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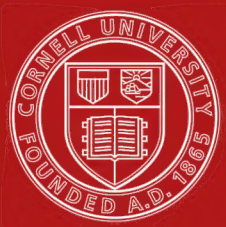

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FIG. 1.—DWELLING HOUSE ON BRYAN FARM.

FIG. 2.—VIEW OF THE POTOMAC FROM BRYAN HOMESTEAD, SHOWING FEEDING PLACES OF GULLS, DUCKS, AND OTHER WATERFOWL.

Mount Vernon in the distance.

U. S. DEPARTMENT OF AGRICULTURE

DIVISION OF BIOLOGICAL SURVEY—BULLETIN No. 17

C. HART MERRIAM, Chief

BIRDS OF A MARYLAND FARM

A LOCAL STUDY OF ECONOMIC ORNITHOLOGY

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Washington, D. C., July 5, 1902.

Sir: I have the honor to transmit herewith, for publication as Bulletin 17 of the Biological Survey, a report on the Birds of a Maryland Farm, the same being a local study in economic ornithology by one of my assistants, Dr. Sylvester D. Judd. Acknowledgment is made to the Entomologist for assistance in the determination of some of the insects, as well as for the use of certain illustrations.

Respectfully,

C. Hart Merriam,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

	Page.
I. Introduction	9
Topography of Bryan farm	10
Distribution of birds	12
Birds that feed in open fields	12
Birds that depend on cover	15
Birds of less limited distribution	17
Birds of varied distribution	19
Topography of Hungerford farm	20
II. Insect food	21
Crane-flies	21
May-flies	22
Infested crops	24
Infested trees and shrubs	28
Certain destructive insects	30
Useful insects	36
Summary	41
Food of nestlings	43
General remarks	48
III. Vertebrate food	50
Poultry and game	50
Fish	53
Carrion	53
Mammals	54
IV. Fruit	55
Cultivated varieties	55
Wild fruit	58
V. Grain	65
VI. Weed seed	70
Weed destruction by native sparrows	72
Weed destruction by other birds	75
VII. Species	79
Water birds	79
Grebes	79
Loons	80
Murres	80
Gulls and terns	80
Ducks, geese, and other waterfowl	80
Herons	81
Rail	81
Coots	81
Shore birds	82
Gallinaceous birds	83
Pigeons and doves	85
Vultures	85

VII. Species—Continued. Page.
Hawks ... 85
Owls ... 86
Cuckoos ... 87
Kingfishers ... 87
Woodpeckers ... 88
Whip-poor-wills, night-hawks, swifts, and hummingbirds ... 91
Flycatchers ... 91
Horned larks ... 93
Blue jays and crows ... 93
Meadowlarks, bobolinks, and cowbirds ... 94
Blackbirds and orioles ... 95
Finches and sparrows ... 97
Tanagers ... 98
Swallows ... 98
Cedar birds ... 99
Shrikes ... 100
Vireos ... 102
Warblers ... 103
Mockingbirds, catbirds, thrashers, and wrens ... 104
Creepers and nuthatches ... 107
Titmice ... 107
Kinglets ... 108
Gnatcatchers ... 108
Thrushes ... 108
VIII. Summary ... 110

ILLUSTRATIONS.

PLATES.

		Page.
PLATE I.	Fig. 1, Dwelling house on Bryan farm; Fig. 2, View of Potomac from Bryan homestead, showing feeding places of gulls, ducks, and other waterfowl	Frontispiece.
II.	Map of Bryan farm, where the investigations were carried on	12
III.	Fig. 1, Bay and hill adjacent to calamus swamp; Fig. 2, Bryan farm from the river, showing shore, bluff, alluvial plain, and forested hills	16
IV.	Fig. 1, River bluff in winter, which shelters several native sparrows; Fig. 2, Hog-lot gully, which furnishes shelter, shade, and food for many birds	16
V.	Fig. 1, Weedy old cornfield, lot 3; Fig. 2, Pasture, lot 1	24
VI.	Fig. 1, Trumpet creeper and other vines of river bluff; Fig. 2, Broom-sedge and briers in hog lot	24
VII.	Fig. 1, Calamus swamp, the haunt of several marsh-loving birds; Fig. 2, Calamus swamp in winter, showing hill tenanted by blue jays, great horned owls, red-shouldered hawks, and ruffed grouse	32
VIII.	Fig. 1, Tobacco field of lot 2, where the effect of birds upon an uprising of tobacco worms was studied; Fig. 2, Sweet potatoes and pear orchard, where various investigations were made	32
IX.	Food of nestlings and adults of three common birds: Fig. 1, House wren; Fig. 2, Bank swallow; Fig. 3, Catbird	48
X.	Fig. 1, Red-tailed hawk; Fig. 2, Short-eared owl	48
XI.	Fig. 1, Sassafras as a weed in lot 5; Fig. 2, Corn injured by crows	64
XII.	Fig. 1, Cornfield, lot 5; Fig. 2, Wheat stubble, lot 3. (The line of trees in the middle ground marks the course of Persimmon Branch)	64
XIII.	Four common seed-destroying sparrows: 1, junco; 2, white-throated sparrow; 3, fox sparrow; 4, tree sparrow	72
XIV.	Fig. 1, Giant ragweed in garden; Fig. 2, Broom-sedge appropriating land	72
XV.	Fig. 1, Bobwhite; Fig. 2, Woodcock	80
XVI.	Fig. 1, Broom-sedge of lot 2, frequented at night by bobwhites; Fig. 2, Partridge pea overspreading pasture of lot 4, eaten extensively by bobwhites. (The pines in the background were defoliated by the pine saw-fly in the spring of 1900)	80
XVII.	Fig. 1, Bluebird at edge of nest; Fig. 2, Former nesting site of bluebirds on lawn at Bryan farm	96

TEXT FIGURES.

		Page.
FIG. 1.	Meadowlark	12
2.	Mourning dove	13
3.	Song sparrow	16
4.	Catbird	18
5.	May-fly	22
6.	Tobacco worm	27
7.	Pale-striped flea-beetle	30
8.	Rose-chafer	31
9.	Kingbird	31
10.	Grasshopper	32
11.	Weevil	34
12.	Ground-beetle	37
13.	Ichneumon-fly	40
14.	Cutworm and moth	42
15.	Dung-beetle	42
16.	Barn swallow	47
17.	Diagram showing proportions of food of common crow	48
18.	Diagram showing proportions of food of crow blackbird	49
19.	Cooper hawk	51
20.	Great horned owl	52
21.	Melons damaged by crows	58
22.	Pellet ejected by crow	63
23.	Some common seeds found in crow pellets	64
24.	Common crow	65
25.	Crow blackbird	67
26.	English sparrow	68
27.	Weed seeds commonly eaten by birds	71
28.	Field sparrow	74
29.	Goldfinch	75
30.	Yellow-billed cuckoo	87
31.	Yellow-bellied sapsucker	89
32.	Flicker	90
33.	Phœbe	93
34.	Blue jay	94
35.	Bobolink	95
36.	Red-winged blackbird	96
37.	Cedar bird	99
38.	Mockingbird	105
39.	Brown thrasher	106
40.	House wren	107
41.	Robin	109

BIRDS OF A MARYLAND FARM.

I.—INTRODUCTION.

The principal method used by the Biological Survey in investigating the food habits of birds is examination of the contents of stomachs, the material for which is obtained from all parts of the United States. In the case of each species the separate data accumulated by examining as many stomachs as possible are tabulated and show the food of the bird in question to consist of various proportions of certain elements. This method, combining as it does data from many parts of the country, gives results necessarily somewhat composite, but certainly trustworthy, and shows to what extent a bird eats fruit, grain, or insects, thus furnishing a comprehensive and detailed knowledge of food habits that probably could not be obtained by any other available means.

In a study of local conditions, however, general conclusions regarding the utility of a bird based on data from perhaps a score or more of States may sometimes require modification. For instance, from a study of the smaller herons from material collected from North, South, East, and West the conclusion would be drawn that they live on food of no economic value and are therefore unimportant species. But a study of these birds in the State of Louisiana alone shows them to be highly useful, for here they prey on crayfish, which, by tunneling through the levees, cause great damage to crops by flood. In similar ways the relations of birds to a certain locality or particular farm can not always be exactly tested by conclusions drawn from a large range of territory. The exact damage to crops is not revealed by stomach examination. A bird may have punctured several grapes in each of a hundred clusters and yet betray to the microscope no sign of its vicious habit. On the other hand, a bird may be condemned as injurious because it is found to have eaten berries or grain, although, as a matter of fact, it has taken the berries from wild plants and gleaned the grain after harvest. Then, too, the material examined at the Department is not usually accompanied by notes of the available supply of fruits, seeds, and insects present at the places where the birds were collected. Such information would be a significant supplement to the results of stomach examination. The faults of a fruit-eating bird might be condoned if it were found to rob the garden and orchard only when the thicket and pasture were barren. And the value of birds as insect destroyers in any particular locality

can be understood only when one knows just what crops of the region are infested, and the identity and importance of the pest by which each is chiefly attacked; for only then can one learn which birds select the worst pests and destroy them in the largest proportion.

With a view to ascertaining how far local conditions might modify the details of general conclusions based on data from widely separated regions, a study of the food habits of the birds on a particular farm was undertaken. From July 30, 1895, to July 24, 1902, visits were made at frequent intervals and including every month of the year except January. To obtain an idea of the available food supply, the insects, berries, and seeds found on the place were collected; the condition of the crops and the insects infesting them were noted; detailed observations of the birds' food habits were made in the field, and the stomachs of 698 birds were collected and examined, 53 being those of English sparrows and the remainder (645) those of native species. One of the most serious disadvantages attending the work is that from such a limited area one can not examine stomachs enough to get a thorough knowledge of the food of each species, and is often compelled to rely, for the general idea of the food, on conclusions drawn from material collected elsewhere. Still, such information, supplemented by the knowledge gained from local stomach collections and field notes, has made it possible in most cases to determine whether a given species is, on the whole, helpful or harmful to the farm in question.

TOPOGRAPHY OF BRYAN FARM.

The farm chosen for this investigation is the Bryan farm, at Marshall Hall, Md., on the south bank of the Potomac, 15 miles from Washington, directly opposite Mount Vernon, Va. (see Pl. I, frontispiece, fig. 2). The former owner of the farm, Mr. O. N. Bryan, was an enthusiastic collector of birds, plants, and Indian implements, and was known to many Washington scientists. On his death, in 1892, his collections were given to the National Museum. The farm passed to his nephew, Mr. George R. Bryan, to whom the author is indebted for permission to conduct these investigations on the place, and for cordial cooperation and uniform courtesy throughout their course. The farm contains about 230 acres, of which 150 is cultivated and most of the remaining 80 covered with timber, principally hardwood interspersed with pine. The arable land, forming as it does nearly two-thirds of the farm, is all in one tract (see map, Pl. II). Its western limit is a straight line of fence separating it from the next farm; its northern boundary, almost twice as long, is the nearly straight shore of the Potomac River, which here flows from east to west. A small bay, formed by an indentation of the river shore (Pl. III, fig. 1), a calamus swamp, 200 yards long (Pl. VII, fig. 1), which drains into the bay, and a tract of woodland (Pl. XVI, fig. 2) form

the eastern and southern boundaries. The uncultivated part of the farm consists of timber tracts, level except about the swamp, where the land rises on two sides, the eastern rise forming a little wooded hill more than 100 feet above the river (Pl. VII, fig. 2).

The cultivated area is a level, alluvial bench extending back from the river a half mile to foothills (Pl. III, fig. 2). It is divided into five approximately equal lots, two along the southern or woodland boundary and three along the northern or river boundary. A straight line of fence parallel to the river separates the three river lots from the two inland lots. The river tract is rectangular, about three times as long as broad, and extends east—that is, up river—several hundred yards farther than the inland tract. A bushy draining ditch, which will be designated throughout this paper by the local name Persimmon Branch, stretches lengthwise through the middle of this area from the calamus swamp to the lower or southwest corner of the farm, where it empties into the river by a swampy, timbered outlet. Persimmon Branch is joined not far from its river mouth by a tributary—locally known as Partridge Branch—that drains the western inland lot. The other inland lot has no ditch, and part of it is often wet; the side toward the swamp washes badly during heavy rains. It has been found convenient to designate these lots by numbers, the three along the river being numbered 1, 2, and 3 and the others 4 and 5 (see map, Pl. II).

The farm meets the river in a precipitous, tree-fringed bluff from 20 to 30 feet high, which at low tide has a strip of sandy shore (Pl. IV, fig. 1). All the buildings but one stand at intervals on a road running along the brink of the bluff. In the middle of the river front of lot 1 are the house, surrounded by a yard with a paling fence and shaded by great locusts, and a horse barn with its corn house (see Pl. I, frontispiece, fig. 1). In lot 2, touching the line dividing it from lot 1, is a cow barn, and at the middle of lot 2 is a negro cabin. A storage barn stands several hundred yards south of the cabin, at the northwest corner of lot 4 (see map, Pl. II).

The staple products of the farm are corn, wheat, and tobacco in irregular rotation with timothy, which furnishes the winter supply for some half dozen cows and about as many horses. In recent years market gardening has been attempted on a small scale, in the light, sandy part of lot 3, between Persimmon Branch and the river. It is seldom that even two-thirds of the five lots is under cultivation at once. Of the remaining third or more, 5 to 10 acres is usually devoted to timothy, and the rest is worn-out mowing lands and weedy old cornfields (Pl. V, fig. 1). Broom-sedge, which in spring makes good pasturage but later is refused by stock, comes into these cornfields after the first year, and, in time, into the timothy fields (Pl. XIV, fig. 3). Of the cultivated area, as much as 30 acres is sometimes devoted to corn. A smaller acreage is given to wheat, and still less to tobacco

(Pl. VIII, fig. 1), which, however, is the most steady in price, and during good years the most profitable crop. Vegetables, strawberries, pears, grapes, and quinces are grown in an inclosed kitchen garden adjoining the dooryard on its upper side. Beyond is a hog lot of several acres, with a small wooded gully leading down to the river and affording shade to the dozen or more hogs that range there (Pl. IV, fig. 2).

DISTRIBUTION OF BIRDS.

After this preliminary account of the topography and the products of the farm we may consider the birds and their relation to the crops. The whole farm with its arable land, river shore, steep bluff, and low calamus swamp bordered on one side by the high hill and on another by the extent of level forest, presents conditions so varied as to attract many different kinds of birds. The actual distribution of the various species is of great importance. Other things being equal, those that live on the arable land, and thus have the best opportunity to check the work of injurious plants and insects, may be expected to do the greatest good, while such as frequent only the swamp or the remote woodland have little effect on crops.

BIRDS THAT FEED IN OPEN FIELDS.

Meadowlark.—The meadowlark (fig. 1) is a good example of species

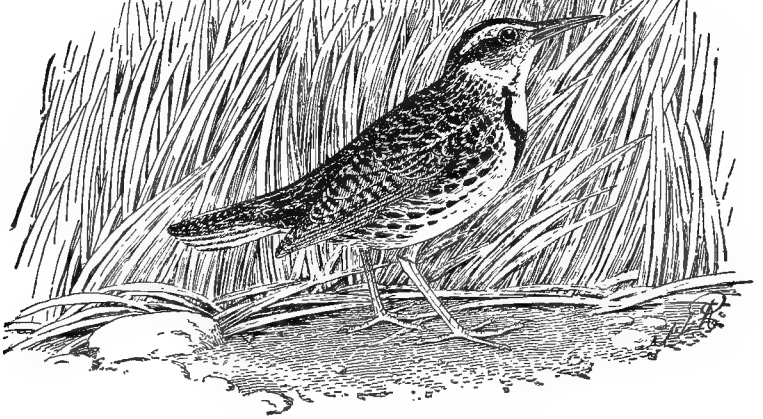
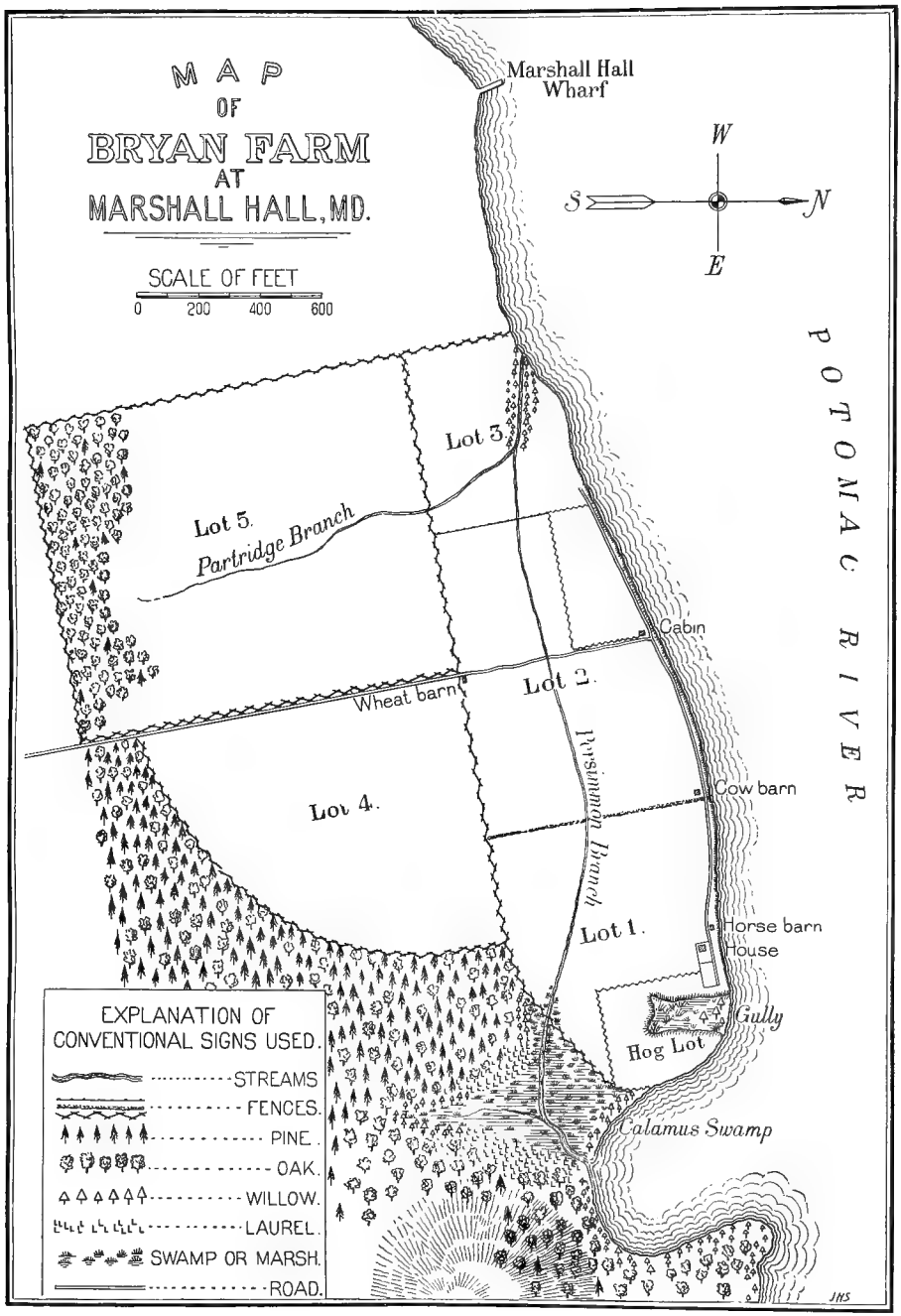


FIG. 1.—Meadowlark.

of the former class. It was found breeding in all the lots, usually in a timothy field or an old weedy cornfield (Pl. V, fig. 1), and was present in numbers sufficient to do much good. In late summer flocks of 20 were often seen, and in November usually more than twice that number. These birds in their feeding completely covered the open parts of the lots, and came fearlessly up to the barns and foraged within a stone's throw of the house.



MAP OF BRYAN FARM, WHERE THE INVESTIGATIONS WERE CARRIED ON.

Grasshopper Sparrow.—The grasshopper sparrow is even more exclusively a bird of the open land than the meadowlark, for it seldom flies up from the fields to perch in trees. During the period of observation it happened to breed for the most part in lots 1, 2, and 3, choosing timothy fields or pastures (Pl. V, fig. 2), or weedy, briery cornfields. It was often seen feeding in lot 5, but was seldom observed in lot 4, probably because the rotation of crops in that lot did not happen to provide favorable grass land.

Bobwhite.—The bobwhite—the quail of the North and the partridge of the South—is also a bird of theopen, though it has the habit of flying to cover when alarmed. Bobwhites were frequently found in coveys of a dozen or more in lots 4 and 5. On being flushed they sought shelter in the neighboring oak woods, where they spent much time, especially in fall and winter. In summer they lived chiefly in the open lots of the farm, where they nested. From the time that corn was 3 feet high until it was cut, they used it for cover. They were not as closely confined to grass land as the grasshopper sparrows, but foraged in every lot, and appeared to come in closer contact with crops than did any other species on the farm.

Mourning Dove.—Among the birds of the first class may also be included mourning doves (fig. 2) and crows, which, though not nesting on the arable land, were always to be seen feeding there. The doves nested in small pines in the more open parts of the adjacent woods. As their food is weed seed and waste grain gleaned on stubble-

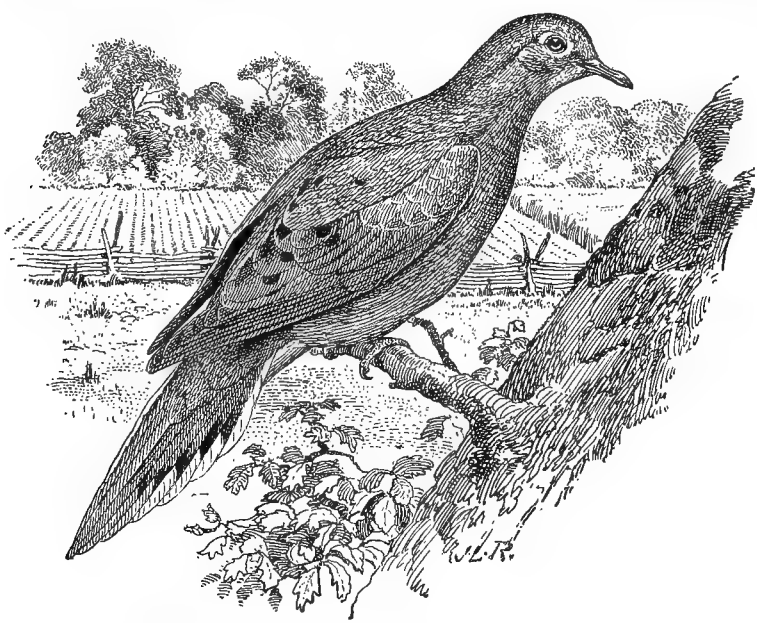


FIG. 2.—Mourning dove. (The background of this picture is typical of the Bryan farm.)

fields, they avoided fields of timothy and broom-sedge and areas under actual cultivation and foraged in waste corn land and on wheat stubble, where, for a time after harvest, they obtained wheat and, later, abundant seeds of ragweed. They were often observed in lots 2 and 3 feeding on the seeds of oxalis, spurge, and other weeds that grew among old cornstalks, and in fall worked among the rank weedy growths that overran the truck land between Persimmon Branch and the river; but they were more often seen in lot 4, which was near the woods where they nested, and which furnished them wheat stubble or new corn stubble with their favorite pigeon-grass. At harvest time and later the flock of doves numbered a score or more. Their feeding grounds changed from time to time according to the rotation of crops. They did not approach the buildings with as much confidence as did the meadowlarks and the bobwhites, and thus lost some effectiveness as weed-seed destroyers.

Crows.—Both the fish crow and the common crow occurred on the farm, but the latter species was much the more abundant. Crows nested in the scrub pines (*Pinus virginiana*) which grow among the white oaks and red oaks bounding lot 4, and bred also in the woods across the calamus swamp, where, in addition to the trees just mentioned, there is a sprinkling of cedar, sycamore, and holly. Their favorite feeding grounds in spring were newly plowed fields where May-beetles and cutworms were to be found. Even when such fields were close to buildings the crows, though usually shyer than the doves, watched for opportunities to visit them, and many times were noticed in the early morning stalking along the furrows, sometimes within a few rods of the cabin, cow barn, and storage barn. As they did not often enter the timothy fields, which were tenanted by meadowlarks and grasshopper sparrows, and as these, on the other hand, were seldom seen on plowed land and among the hoed crops where the crows constantly foraged, the work of the latter was, in a measure, complementary to that of the former.

Blackbirds.—The crow blackbird, although it did not nest on the farm, was a frequent visitor. During the breeding season its favorite haunt was the cherry trees along the river bluff, but in spring and fall it foraged in flocks over all the lots of the farm. Sometimes with this bird, but more often in separate flocks, the rusty grackle visited the farm during migration. At this time also, the cowbird, often in large flocks, appeared in the open fields and helped to reduce the weed-seed harvest; but during the breeding season the species was limited to several pairs, which were generally to be seen walking about the pastures at the heels of the stock.

Other birds.—The robin, though not breeding at Marshall Hall, was abundant in spring and fall, and might be found foraging out in the centers of the largest fields. The goldfinch showed the same fondness

for the open and was often observed feeding far afield in flocks of from 100 to 300. Of the birds of the open, that fed far out in all the five lots and did not depend on adjacent cover, there remain but two to be mentioned, the vesper sparrow and the savanna sparrow, which visited the farm only during migration, but helped, nevertheless, in the valuable work of destroying weed seeds.

BIRDS THAT DEPEND ON COVER.

Cover furnished by farm.—Other species, mainly sparrows, though occurring on the arable area, fed less generally out in the centers of the fields, and depended on protecting cover. This was afforded in part by an osage orange hedge which bounds three sides of lot 2, and by blackberry bushes and cedar and sassafras trees along fence rows. Excellent cover was furnished, also, by a narrow belt of locusts, cedars, and cultivated cherry trees along the edge of the river bluff, and by a tangle of blackberry, honeysuckle, smilax, wild grape, bittersweet, and trumpet creeper that grows under the trees and in many places covers the face of the bluff (Pl. VI, fig. 1). Other good cover, nesting sites, and feeding grounds are afforded by the trees and bushes around the house, by the forested gully of the hog lot (Pl. IV, fig. 2), and by the timbered outlets and bushy upper courses of Persimmon Branch and Partridge Branch. (The course of Persimmon Branch near the outlet can be seen in Pl. XII, fig. 2.) To the thickets of the hedgerows and streams is due the presence on the arable land of many species that would not live on unwatered and wholly cleared farms.

Field Sparrow.—The field sparrow, which appears so often in the open that it may almost be grouped with the preceding class, is found, on observation, to be dependent on cover. But it is a bird of the broom-sedge and briers, and its presence is not conditional on the neighborhood of large trees, water, or buildings, as is that of some other sparrows. Its nesting sites included each side of Persimmon Branch, the broom-sedge and dewberry tangle of the high part of the hog lot (Pl. VI, fig. 2), and the crest of the bluff overlooking the swamp. After the young were fledged small flocks of two or more families followed the branches, hedgerows, brush piles, and fence rows all about the arable part of the farm, even finding their way along a rail fence to tobacco seed beds in the woods. The field sparrows avoided timothy, but foraged far out in weedy old cornfields where the stalks remained standing, and when new corn had tasseled they fed under its shelter. They were found with most certainty, however, in waste grounds bearing little but broom-sedge and briers.

Chipping Sparrow.—The chipping sparrow, the field sparrow's congener, in conformity to its semidomestic habits, nested in the door yard, the kitchen garden, the adjacent orchard, and cedar trees near the storage barn. It was characteristic of roadside and rail fence and

foraged in cropped pastures and among hoed crops. Unlike the field sparrow, it sought cover, not in bushes, but in trees isolated as in orchards. On account of these habits its work is more or less complementary to that of the field sparrow. Neither species was noticed feeding to any important extent in standing timothy, the habitat of the grasshopper sparrow, but they both destroyed weed seeds and insects over a large part of the farm, even out in the center of lot 4 far from cover. In August and September they fed together in loose flocks along fence rows. At this time there were nearly a hundred of the two species, the chipping sparrow being the more numerous.

Song Sparrow.—The song sparrow (fig. 3) is a bush bird, which, though feeding on the ground, is generally too cautious to venture far afield. It is essentially a bird of the waterways, and bred in the undergrowth along Persimmon Branch and the river, in the hog-lot gully, and about the calamus swamp; yet, like the chipping sparrow, it came with confidence up to all the buildings. It foraged over the garden and dooryard and along a strip several rods wide extending from the house to the mouth of Persimmon Branch. In feeding here it usually avoided the open parts of newly plowed fields, but ran amid corn, wheat, tobacco, truck, and timothy, and, as will appear later, did considerable good in this way. It spent much time along the river shore, however, and thus wasted opportunities for protecting crops. In summer it was less abundant than the chipping sparrow or the field sparrow, but after the breeding season it came down from the North in great flocks and did good work among weeds.

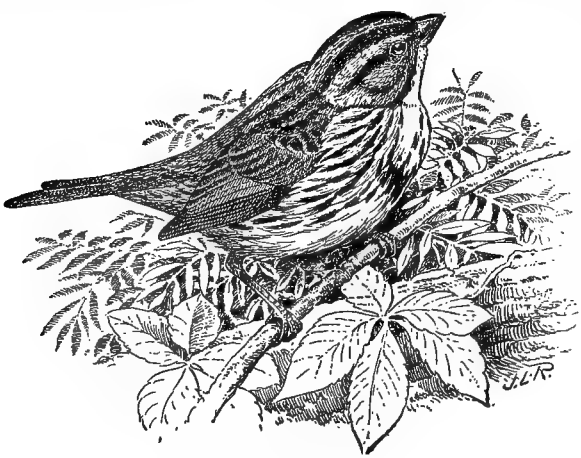


FIG. 3.—Song sparrow.

Other native sparrows.—Fox sparrows, and many tree sparrows, juncos, and white-throated sparrows also come down from the North in the fall. The fox sparrows are cover-loving birds, and frequented the tangle of the river front and Persimmon Branch, seldom venturing more than a rod into the fields. The whitethroats usually associate with song sparrows, and were found all along hedgerows and waterways. The tree sparrows associate with field sparrows, and like them preferred broom-sedge fields, though they, too, often followed the

FIG. 1.—BAY AND HILL ADJACENT TO CALAMUS SWAMP.

FIG. 2.—BRYAN FARM FROM THE RIVER, SHOWING SHORE, BLUFF, ALLUVIAL PLAIN, AND FORESTED HILLS.

FIG. 1.—RIVER BLUFF IN WINTER, WHICH SHELTERS SEVERAL SPECIES OF NATIVE SPARROWS.

FIG. 2.—HOG LOT GULLY, WHICH FURNISHES SHELTER, SHADE, AND FOOD FOR MANY BIRDS.

hedges and water courses. The juncos are an independent species, taking refuge in large trees as well as in bushes, and foraged far afield, even in bare and exposed situations.

English Sparrow.—In addition to the native sparrows, the English sparrow occurred on the farm. Its distribution depended solely on suitable nesting holes and available grain. A dozen pairs bred in the crannies of the house, in an old dovecote on the granary, and in the dooryard locusts. At harvest time the flock numbered 100 or more. No part of the farm was too remote for their forays if it yielded them grain, so their feeding grounds varied with the rotation of crops. They were often to be seen, also, gleaning amid poultry and stock at feeding time, and stealing into the corn crib. The presence of this bird had affected the distribution of other species, particularly such as nest in cavities. The bluebird had been driven from the farm, and many of the house wrens that formerly bred about the buildings had had to seek more secluded places. A few pairs of wrens continued, however, to nest near the house in cavities too small to admit the sparrow. Others lived at both mouths of Persimmon Branch and the lower end of the hog-lot gully (Pl. IV, fig. 2).

BIRDS OF LESS LIMITED DISTRIBUTION.

Kingbird and Oriole.—About a dozen pairs of kingbirds and orchard orioles were also on the place. Neighbors at nesting time and often associates in their feeding range, they lived together in fruit trees by the house, and were also noted at the negro cabin and on the shore by the calamus swamp.

Wherever a kingbird's nest was discovered, a nest of the oriole was sure to be found in the same or an adjoining tree. It seemed odd that such a tyrant as the kingbird should tolerate such close proximity. The kingbirds skimmed over all the five lots after insects, occasionally poising on weedstalks and often perching on the highest trees along the river bluff and the hedgerows. The orioles, though not infrequently seen along fence rows, were generally confined to the trees of the river front, whence, however, they flew out into the adjacent mowing land to pick up insects from the ground.

Cedar Bird.—From a dozen to a score of cedar birds also frequented the trees along the river, though they did not nest on the farm, and they were often noticed at the ends of Persimmon Branch and in the hog-lot gully. Their distribution appeared to depend on the presence of ripe fruit, such as mulberries, cherries, blackberries, or cedar berries.

Catbird.—The most abundant summer bird was without question the catbird (fig. 4). Its usual habitat was practically the same as the song sparrow's—that is to say, the undergrowth of moist places. But while the

song sparrow preferred thickets of blackberry, elder, and alder, somewhat open to the sun, the catbird chose tangles of catbrier deeply shaded by overspreading trees. It was therefore numerous in the swampy, forested dells at the extremities of Persimmon Branch (see map, Pl. II), and still more so in the hog-lot gully (Pl. IV, fig. 2),

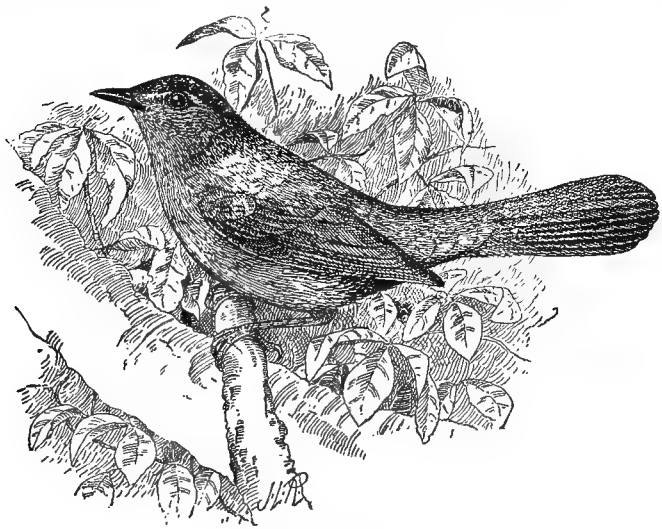


FIG. 4.—Catbird.

where it found attractive food, consisting of cherries, mulberries, blackberries, and elderberries, besides May-flies, which were abundant before the fruit ripened. Here, in one morning, fifteen catbirds were seen. Like the song sparrow, this species came up to nest about the house. One pair built in a holly by the gate, another near the horse tub, and two pairs in the garden. All these families fed among the vegetables and moved about under the apple trees and in the dooryard. The catbird is arboreal to the extent of securing probably three-fourths of its food in trees or bushes. Because of this fact, and also because its feeding range does not extend out into fields, it does not appear to have a close relation with crops.

Other birds.—One or two pairs of cardinal grosbeaks bred on the river bluff, but more were noticed in the edge of the swamp bordering the arable land. They built chiefly among catbriers, in stunted young scrub pines, and in the tops of fallen oaks. Cardinals were also seen along the wooded parts of Persimmon Branch, and may have bred there. Two pairs of yellow-breasted chats nested close to crops, one in the thick undergrowth of Persimmon Branch and the other in a similar shaded thicket at the northeast corner of lot 4. Indigo birds and brown thrashers nested near the storage barn, phœbes in the cow barn, and swifts in the chimneys of the house.

BIRDS OF VARIED DISTRIBUTION.

The distribution of the birds remaining to be mentioned can not be so definitely limited. Various gulls and ducks were present in the river during the colder months. The least bittern, great blue heron, little blue heron, little green heron, and sora rail occurred in the calamus swamp (Pl. VII, fig. 1), and the little green heron was also noted feeding all along the river (Pl. III, fig. 2). Woodcock were found on Persimmon Branch near the river, and were observed at dusk flying into adjacent cornfields. Sandpipers, usually the spotted, but now and then the solitary, were to be seen, particularly at the mouth of the hog-lot gully, teetering along the beach in twos and threes.

Various species of hawks, including the broad-winged, red-tailed, red-shouldered, marsh, Cooper, sharpshinned, and sparrow hawks, occurred on the farm. One pair of Cooper hawks bred in the scrub pines on the edge of lot 4. Broad-winged and red-shouldered hawks built on the slope of the wooded hill that rises from the calamus swamp (Pl. VII, fig. 2). Eagles frequently came over from Virginia, and one established a post in a large tree on the bluff just below the negro cabin. Ospreys sometimes passed the farm on fishing trips up and down the river. Several pairs of great horned owls and screech owls built in the woods above the calamus swamp (Pl. VII, fig. 2). Turkey buzzards soared over the fields and often fed along the shore: some nested beyond the farm in the chestnut stumps of a deep, narrow gully.

Kingfishers, which bred in the sandy face of the bluff beyond the farm, fished in the calamus swamp and along the river front. The downy woodpecker foraged in all the fruit trees and nested in the hog-lot gully, at the river mouth of Persimmon Branch (see map, Pl. II), and also in some of the most remote woodland. Flickers, though breeding at Marshall Hall, were most numerous in spring and fall, when they frequently fed in open fields with robins. Sapsuckers were seen in various places during the colder half of the year, very often in the apple orchard by the kitchen garden. The red-headed woodpecker also occurred, but its distribution was very erratic. Night-hawks sometimes appeared in the late afternoon, circling after insects, and whip-poor-wills were frequently heard, though seldom seen. Hummingbirds were seen in various places about the farm dipping into the flowers of the trumpet creeper, persimmon, and tobacco. One nest was discovered on a horizontal bough on a red oak beside Persimmon Branch. Another was found fastened to the limb of a box elder in front of the farmhouse.

Two pairs of wood pewees nested in the kitchen garden and the dooryard, and more than a dozen pairs bred in the recesses of the woods. The great crested flycatcher habitually stayed in solitary

retreats and journeyed over to the hog-lot gully, the river front, and even the dooryard. Several pairs of blue jays and scarlet tanagers frequented the oaks bordering lot 4. Two or three pairs of red-winged blackbirds, that sometimes fed on the cultivated land, nested in the calamus swamp (Pl. VII, fig. 1). Purple finches were found during the colder half of the year along the brink of the bluff. Barn swallows nested in the cow barn one summer, but the individuals usually seen were visitors from other farms, as were also the purple martins, white-bellied swallows, and rough-winged swallows, that mingled with the barn swallows, often in a flock of a hundred, and skimmed over the field in pursuit of insects.

The red-eyed vireo, in summer one of the most abundant species on the farm, built in trees everywhere, but was most numerous in deciduous woodland. Having strictly arboreal habits, it did not feed among field crops, but protected the foliage of orchard, shade trees, and woods. The white-eyed vireo was found in moist places outside of the cultivated land and also in the woodland about the calamus swamp. The last-named locality sheltered large numbers of migrating warblers in spring and fall. Here at these seasons could be noted the black-throated blue warbler, myrtle warbler, magnolia warbler, black-poll warbler, black-throated green warbler, pine warbler, prairie warbler, oven-bird, the two species of water-thrushes, Wilson's blackcap, and the Canadian warbler. The yellow warbler built near the house and also in willow swamp land back from the arable area. The redstart nested on the west side of the swamp. The Maryland yellow-throat, rivaling the song sparrow in numbers, frequented all the moist, bushy regions, but often came out into the five lots to feed along the fence rows, and was sometimes seen scurrying among the leaves of tobacco. Half a dozen or more pairs of long-billed marsh wrens had nests in the swamp (Pl. VII, fig. 1). Carolina chickadees nested near the swamp and in the pin oaks of the woods near lots 4 and 5, and several were seen in the orchard and the hog-lot gully. Tufted titmice were occasionally observed in the neighborhood of the swamp and the same woods. Kinglets of both species occurred in the apple orchards. The hermit thrush, olive-backed thrush, gray-cheeked thrush, and Wilson's thrush occurred during migration in the oaks bordering lot 4. The wood thrush was found breeding in the forest east of the calamus swamp (Pl. VII, fig. 2), but never came out into the garden or house yard, as it often does in more northern States.

TOPOGRAPHY OF HUNGERFORD FARM.

In order to study the effect of birds on a greater variety of crops than were grown on the Bryan farm alone, the next two farms, namely, the Marshall farm and the Hungerford farm, which were conveniently situated for the purpose and were kindly placed at my service by the

owners, were visited from time to time. A brief description of the latter, on which most of these subsidiary observations were made, is necessary for a clearer understanding of the results here set forth. It is primarily devoted to truck and fruit, though it produces also wheat, corn, and tobacco. A hedgerow of large cedars cuts it into two parts, each part with its house and barn. The upper section has a swamp fed by a bushy brook and emptying into the river, while the lower section is drained by two ditches merging into one at their river outlet. There is also a timbered dell, shallow and swampy, which extends from the river back into the cultivated fields, and which harbored a colony of breeding crow blackbirds, more than a dozen catbirds, several woodcock, and at least two pairs of cardinals. Along the Hungerford farm the bluff is seldom half so high as on the Bryan farm, and in many places is entirely wanting.

II.—INSECT FOOD.

In studying data derived from the examination of stomachs collected over areas widely diverse in latitude and longitude the investigator seldom knows exactly what kinds of insects were available for selection at the time the food in the stomachs was obtained, how abundant relatively the various species of insects were, and to what extent, if any, they were injuring crops. He is therefore in some danger of misinterpreting results, especially when he attempts to show how the birds' insectivorous habits relate to agriculture in specific cases. He may, for instance, commend birds for having fed on a certain pest, when, as a matter of fact, they had found no other food available, or he may condemn them for not having eaten injurious insects when the district from which they came happened to be free from such plagues. For this reason, therefore, a careful study was made of the relative and absolute abundance of the different kinds of insects on the farm at each visit. It may be mentioned here that in recording observations of this kind the calendar date should be supplemented by the biological date, which shows the advancement of the season and is best determined by the condition of the vegetation; but this rule has not always been followed in the present report.

CRANE-FLIES.

The most interesting visits were, naturally, those made when insects were most numerous. Crane-flies appeared every year, but during 1900 were unusually abundant. The farm was visited on April 22 of that year when the forests were bare and the fields brown. Peach, plum, and pear were in bloom, but the apple was not yet out. Crane-flies were seen everywhere, but were thickest in the grass land of lot 1, where they fairly swarmed on the ground and flew into one's eyes,

nose, and mouth. No birds were collected, for it was evident that all were feeding on crane-flies, which formed the only abundant supply of insect food. Several species of sparrows, including song sparrows, white-throated sparrows, and chipping sparrows, were observed greedily eating them. A pair of kingbirds left their perch on an apple-tree spray every now and then to snap up the insects, and a Maryland yellow-throat, several meadowlarks, and a pair of bobwhites feasted on the swarming prey. These insects fly feebly and are easily caught; and since there is hardly an insectivorous bird that is not known to take them, it seems safe to conclude that when they are abundant they are eaten in great numbers. Coming as they do in the spring, when other food is scarce, they are a boon to birds. They supply both the newly arrived species and those that are about to journey to their northern nesting grounds. The destruction of crane-flies by birds is a benefit to the farmer, as they are injurious to grain and grass. Their larvæ, repulsive, leathery-looking objects, feed underground, largely on roots. Crane-flies are said to do great damage in Europe, but are much less important in this country.

MAY-FLIES.

Of all the insects on the farm, the May-fly (fig. 5), during the period of its aerial life, is undoubtedly the most abundant and the most conspicuous. The respective numbers of other species fluctuate greatly from year to year, but the myriads of this plague are nearly always constant. Fortunately the life of the adult lasts only from a few hours to two days. As a water nymph, however, the insect lives from one to three years. When the locust trees are dropping their blossoms, usually about the middle of May, the nymphs rise to the surface of the Potomac, transform into adults, and flutter to the shore. The suddenness with which they appear and their vexatious numbers may be understood from a description of the conditions that prevailed at Marshall Hall from the 13th to the 15th of May, 1900. On the morning of the 13th not a May-fly was to be seen. In the late afternoon several were noticed along the shore. On the 14th many came up from the river and flew around the house, and on the morning of the 15th thousands were found clinging to the porch. They soon spread all over the farm, or, more strictly speaking, were blown over it. The air was full of them. After a walk of a hundred yards along the bluff in lot 3, I found 67 clinging to me. They covered the cedar trees beside the river, turning the dark green of the foliage to a distinct gray. They frightened the horses so badly by alighting on them that plowing was suspended for several days. They swarmed into the house and made meal-times almost unendurable. This condition

FIG. 5.—May-fly (from Packard).

seldom lasts more than a week or two. Soon the dead bodies of the short-lived creatures are cast up all along the shore in windrows several inches high, and then there is a marked decrease in their abundance about the farm. They occur, however, though in constantly diminishing numbers, throughout June and even into July.

At their flood tide they furnish most of the food of practically all the birds of the farm, even including barnyard fowls. They are soft, entirely edible, and highly nutritious, owing to the fact that the females are heavy with eggs. Any bird, no matter how clumsy, can capture them as they make their aimless, blundering flights, or fall helplessly from contact with objects in their way. It was interesting to see the methods by which different birds procured them. A green heron, three spotted sandpipers, several song sparrows, and a dozen crow blackbirds frequented the beach, picking up insect after insect. Woodpeckers and at times Carolina chickadees snapped them up from tree trunks in the apple orchard or the hog-lot gully. The parula warbler, the yellow warbler, and one or two other warblers, with the white-eyed vireo and the red-eyed vireo, gathered them from among leafy boughs. The redstart darted out and caught its share of the quarry on the wing. Some species fed in a lazy, sated manner. Thus in the top of a cedar that was gray with the insects, five crows sat for half an hour slowly choking them down. A pair of red-winged blackbirds and several blackpoll warblers later visited the same tree to feed. Such flycatchers as the phœbe, the wood pewee, the kingbird, and the great crested flycatcher stood nervously at their sentry posts, every now and then rising to hover and snap up a victim. The kingbird had another, more interesting method of feeding. Perched in the dead top of a tree, it would make a dash into one of the lateral boughs of an adjacent locust that was so heavily laden with May-flies that the tips of the branchlets drooped under the weight, dislodge hundreds of the insects, snap up several as they fluttered out, and then return to its perch. Over and over it played this game, apparently with keen zest. I watched a similar, though less adroit, performance by a female catbird that spent a long time gathering food for her young from a maple in the dooryard. Every few minutes she would take a short flight and drop on the end of a slender bough; then from the scores of May-flies shaken out she would, by clumsy efforts, generally manage to catch one. A hen with her brood of eleven chicks derived the chief profit from the bird's industry, and remained for two hours gobbling up the manna that rained from the maple tree. English sparrows also shook the insects from the branches and captured them on the wing. A flock of a dozen cedar birds pursued them through the air, appearing to swim rather than fly, and reminding one of a lazy sunfish dawdling after a baited hook. At other times, possibly when they were more hungry, they caught their prey with an alert-

ness that would have been creditable in a flycatcher. Swifts and a variety of swallows, including the tree swallow, the bank swallow, the rough-winged swallow, the barn swallow, and the purple martin, appeared to feed on May-flies exclusively. Whenever a kingbird dashed into a tree these birds would fly by the dozen to the spot and seize the fluttering, helpless insects that had been dislodged. When, however, a gust of wind drove the May-flies before it, the swallows were seen to best advantage as they circled gracefully after them.

Field observations and the examination of stomachs proved that 40 species had eaten May-flies, but this number probably represents only about half the truth. Not many birds were collected at the height of the insects' abundance, because even casual observation showed that practically all the birds of the farm, not only the highly insectivorous species, but also the species chiefly frugivorous or granivorous, turned to them for food. The following is the list obtained:

List of birds known to have fed on May-flies.

Green heron.
Woodcock.
Spotted sandpiper.
Yellow-billed cuckoo.
Black-billed cuckoo.
Downy woodpecker.
Chimney swift.
Kingbird.
Great crested flycatcher.
Phœbe.
Wood pewee.
Blue jay.
Common crow.
Bobolink.
Red-winged blackbird.
Orchard oriole.
Crow blackird.
English sparrow.
Field sparrow.
Cardinal.
Purple martin.
Barn swallow.
White-bellied swallow.
Bank swallow.
Rough-winged swallow.
Cedar bird.
Red-eyed vireo.
Parula warbler.
Yellow warbler.
Black-poll warbler.
Water-thrush.
Maryland yellow-throat.
Yellow-breasted chat.
Wilson warbler.
Redstart.
Catbird.
House wren.
Carolina chickadee.
Blue-gray gnatcatcher.
Gray-cheeked thrush.

Though May-flies furnish valuable food for fish and do no harm to crops, they are of course a plague when they become so numerous. Broadly considered, however, their consumption by birds is a misfortune, for it suspends or prevents the destruction of really injurious insects. At no other time do all birds eat so large a proportion of insect food, for at no other time do they find such a scarcity of other suitable food, and if their attention were not diverted by this easy and palatable prey they might be expected to do the best of their work against insect pests. This unfavorable condition is, however, strictly local, lasts only a few days, and would not occur on areas remote from large bodies of fresh water where the May-fly breeds.

INFESTED CROPS.

At each visit the crops were inspected for pests, and whenever any crop had suffered appreciably it was regularly watched to see whether birds came to its relief. Stomachs were collected also around the infested fields.

FIG. 1.—WEEDY OLD CORNFIELD, LOT 3.

FIG. 2.—PASTURE, LOT 1

FIG. 1.—TRUMPET CREEPER AND OTHER VINES OF RIVER BLUFF.

FIG. 2.—BROOM-SEDGE AND BRIERS IN HOG LOT.

White potatoes.—The potato beetle (*Doryphora 10-lineata*) caused every year considerable injury to white potatoes. During May, 1899, it had destroyed at least half of the foliage of several acres of potatoes about 6 inches high in lot 3. The field was watched for an hour or two each day for several days, but only three birds were seen in the patch—a pair of bobwhites, which are noted potato-beetle eaters, sometimes consuming from 50 to 100 at a single meal, and a cardinal, which is a near relative of the rose-breasted grosbeak, probably the the most valuable destroyer of the pest. Unfortunately neither species could be either observed feeding in the patch or subsequently collected. Other birds were very abundant along Persimmon Branch and the river front, but appeared to manifest no interest in potato beetles. From May 28 to May 30, 1896, the potatoes in the kitchen garden, though in fair foliage, had from several to a dozen beetles on each plant. Birds were about the garden all the time. Forty of them, principally catbirds, vireos, house wrens, chipping sparrows, summer warblers, orchard orioles, and flycatchers were collected, but none had eaten the beetles. On the 16th of June, 1901, a large patch of potatoes by the negro cabin in lot 2 was infested. Above it circled a score of swifts and swallows, mainly barn and bank swallows, with a few purple martins. They did not touch the beetles, but caught caddis-flies, which were numerous over the patch.

The caddis-fly, very abundant and regarded by birds as a choice morsel, may, like the May-fly, distract their attention from other insects. It usually appears about the last of May or the first of June, and it is greedily eaten by many species, especially by arboreal and aerial feeders. It is a harmless insect, whose larvæ lead an aquatic existence. It, too, like the May-fly, would be excessively abundant only near large rivers or lakes.

String beans.—At a time when potatoes were suffering in the kitchen garden (May 28–30, 1896), a dozen rows of string beans beside them were ravaged by thousands of bean flea-beetles (*Cerotoma trifurcata*), but none of the 40 birds collected had preyed on them, a fact possibly due to the presence of caddis-flies. Another uprising of these beetles was observed May 17–20, 1899, but then May-flies were abundant enough to engross the birds' attention. This beetle is similar, however, to species that are eaten by many kinds of birds, and, under other circumstances, might perhaps have been destroyed in large numbers

Sweet potatoes.—Two tortoise beetles injure sweet potatoes (Pl. VIII, fig 2) at Marshall Hall. The more common one (*Coptocycla bicolor*) has the power to change its color, and at its brightest looks like a drop of molten gold, from which it is generally known as the 'gold bug.' During June, 1899, it was especially abundant. On the Marshall Hall farm, near a small plot of sweet potatoes that it was injur-

ing, 20 birds, principally kingbirds, wrens, and chipping sparrows were collected. None of them had molested it. On the Bryan farm, in lot 3, it was so abundant that it killed every plant in a patch of several acres. The lot was watched for an hour or two for three days, but no birds were seen coming to the relief of the dying plants. On the Hungerford farm, 24 birds, largely wrens, barn swallows, and catbirds, were collected near infested plots, and one bird, a catbird, was found to have eaten a tortoise beetle. This fact appears to show that the insect is not unpalatable to catbirds, which might therefore have given some help to the potatoes if cherries had not been so plentiful.

Cabbages.—Three pests attacked cabbages—the wavy-striped flea-beetle, the common cabbage worm, and the harlequin cabbage bug. During the middle of June, 1899, the beetle was found in numbers varying from a dozen to a score on each plant of a cabbage patch on the Hungerford place, near the dell where the crow blackbirds breed. No birds were observed among the cabbages. Ten catbirds were collected in the dell, but they had fed mostly on May-flies. If these tempting insects had not been present, and if birds had come into the patch, doubtless they would have eaten the beetle, for it is closely allied to other forms on the farm that are eaten with avidity. The cabbage worm (*Pieris rapæ*) did considerable damage during June and July of 1896 and 1899 in the Bryan kitchen garden. From six to a dozen worms could be found on every cabbage. A few stomachs of catbirds, chipping sparrows, and other species numerous around the garden were collected, but none contained the worms. The patch was carefully watched for five days. Song sparrows, catbirds, and chipping sparrows frequently hopped among the cabbages, but were not seen to eat the worms. This was surprising in the case of the chipping sparrow, for it is known to hop up into cabbage plants and extract the larvæ. In one instance the kingbird fed on the butterfly of the cabbage worm. The harlequin cabbage bug occurred only once in injurious numbers, and then on the Marshall farm. From 20 to 50 bugs could be counted on each plant. Several field sparrows and grasshopper sparrows, the only species near the patch, were collected, but had not taken the bugs. Other observations have shown that birds do not like these insects, and consequently can not be depended on to destroy them.

Lima beans.—During the last week of June, 1899, the 12-spotted cucumber beetle (*Diabrotica 12-punctata*) was very abundant on lima beans, though not injuring them seriously. Twenty birds were collected close by, half of them chipping sparrows and the others kingbirds, house wrens, and goldfinches. None had eaten the beetles. The bobwhite and the white-eyed vireo, which feed on them, were not at hand.

Peas.—Next to the beans was a patch of peas so ravaged by the pea plant-louse that the crop was a total loss. Only one of the 20 birds had eaten it—a chipping sparrow. It was somewhat surprising to find even one, for the various species of plant-lice are seldom utilized by birds for food, but later it was learned that the chipping sparrow had elsewhere been found preying on the pea plant-louse. This insect has only recently become known to science. It suddenly made its appearance along the Atlantic coast and occasioned a loss of $3,000,000 in the first season.[a]

Melons.—Melons at times suffered badly from insects. In lot 4, not far from the woods, a patch of watermelons in the critical stage of growth, when the first leaf had appeared between the thick, nutritious cotyledons, was ravaged by three species of leaf-beetles—*Diabrotica 12-punctata*, *D. vittata*, and *Systena elongata*. There were from six to a dozen beetles on each plant, and they ate so many of the cotyledons that practically the whole piece had to be replanted. When they were most abundant the patch was watched for several hours on June 15, 1899, and again on June 16, but no birds came to its aid. Birds are known to eat these three insects at times, but the remoteness of the melon field from water courses, hedgerows, and other cover attractive to the most abundant species may explain their failure to do so in this case. At the same date (June 15, 1899) *Diabrotica vittata* was found on canteloupes in blossom on the Hungerford farm, but although there were from 12 to 20 insects on each plant, they appeared to be doing little harm. The patch was observed for an hour in the late afternoon, and three field sparrows, the only birds near it, were collected, but none of these insects were found in their stomachs.

Tobacco.—During the last of August and first of September, 1899, tobacco was grown on the Bryan farm in lot 2 near the negro cabin (Pl. VIII, fig. 1), and also on the other two farms. The entire crop was

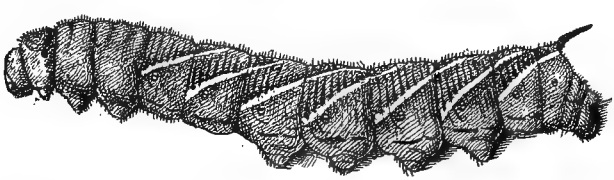


FIG. 6.—Tobacco-worm (after Howard; loaned by Division of Entomology).

damaged by worms (fig. 6) to the extent of 50 percent of its value, in spite of the fact that men, women, and children turned out to pick worms every day for two weeks. When the pests were most abundant (August 28–31) an effort was made to learn whether birds were joining in the war against them. Field sparrows and chipping sparrows spent considerable time hopping among the plants, a song sparrow

[a] Circular 43 (2d. series), Div. Entomology, Dept. Agr., p. 3, 1901.

and several wrens went into the field often, and two Maryland yellow-throats scurried among the leaves. Forty birds were killed in the vicinity of tobacco fields. They comprised, for the most part, the several species of native sparrows that breed on the farm, including also a few wrens, meadowlarks, flycatchers, and others. Not one of the 40 had fed on tobacco worms, although observations on the farm at other times had shown that birds eat them as well as other sphinx caterpillars. Bobwhites and vireos take them, but were not represented in the collection. The chipping sparrow had eaten them at other times, the English sparrow had been seen picking them from the plants, and the crow is known to be an habitual 'wormer.' In June, 1900, an old crow and five young stayed near tobacco in lot 1 for ten days. In the early morning and late afternoon the youngsters would sit clamoring on the fence, while the mother bird brought them worms from the field.

By way of summary it may be stated that while the observations made to determine whether or not the birds of the farm were protecting field crops from insects yielded in the main negative results, they do not lead to the conclusion that birds are of no service. They do indicate, however, that birds are not to be depended on to check uprisings of insect pests, and that insecticides should be used freely and repeatedly. In case of this farm it is probable that the superabundance of May-flies and caddis-flies diverted the birds' attention from pests to the hordes of harmless insects. The pea plant-louse is a new species, unfamiliar to birds, which, however, seldom eat plant-lice. The potato beetle, though unpalatable and avoided by many birds, is eaten with relish by the bobwhite. Had an especial effort been made to collect this bird in infested fields, it would probably have been found to be doing much to reduce the numbers of the pest. Tobacco worms have also been attacked by the bobwhite as well as by the crow, English sparrow, and chipping sparrow; and it is likely that when these worms are small many species of birds feed on them.

INFESTED TREES AND SHRUBS.

Fall webworm.—The next group of observations concerns insects that attack trees and shrubs. The fall webworm occurred regularly at Marshall Hall. It was most often found on willow, black walnut, mulberry, apple, and pear trees. At a time when it was not especially abundant 62 birds, largely catbirds, sparrows, orioles, warblers, and flycatchers, were collected. One of the orioles, a male Baltimore, had eaten webworms. During the middle of June, 1899, webworms defoliated parts of apple and pear trees. A number of stomachs were collected and the trees were closely watched, but nothing gave evidence that the pest was being destroyed. During the last of August, 1896, it was so abundant that it defoliated all the willows of the hog-lot gully and fairly festooned the branches with webs. The trees were

watched for three hours, August 23. Catbirds and vireos, though numerous, did not molest the larvæ, but a pair of yellow-billed cuckoos continually extracted them from the webs. The destruction of this insect is an habitual practice with the cuckoo. In a single stomach of the species examined by Professor Beal there were 325 of the larvæ.

Saw-flies.—In August, 1896, also, the willow saw-fly (*Pteronus*) was defoliating the willows farther up the gully. No birds were observed preying on it, though the cuckoo is known to relish saw-fly larvæ, sixty of which were found in a cuckoo's stomach examined by Professor Beal. The cornel bushes of the same gully were almost every year stripped by the larvæ of another saw-fly (*Harpiphorus varianus*). On July 30, 1895, they covered every large bush, and later they devoured all the foliage. A dozen catbirds and several birds of other species were constantly near the bushes, but evidently did not touch the insects. A repetition of these circumstances was noted August 2, 1896. An interesting outbreak of the pine saw-fly (*Lophyrus*) occurred May 17, 1900, in which hardly a dozen pine trees in the woods adjoining lot 4 escaped attack. In the areas of woodland where the insects had finished their work the trees cast no shade and appeared to be dead. In places where the larvæ were feeding their dropping excreta made a continuous patter like that of falling rain. From the infested district 34 birds were collected, comprising the following species: Great crested flycatcher, wood pewee, blue jay, crow, scarlet tanager, red-eyed vireo, white-eyed vireo, magnolia warbler, black-poll warbler, oven-bird, chat, Canadian warbler, redstart, gray-cheeked thrush, and olive-backed thrush. Seven birds, including the black-poll warbler, the red-eyed vireo, and the gray-cheeked thrush, had eaten the insect. Since it has not yet been found practicable to protect forest trees by means of insecticides, such services as birds render among these pests ought to be appreciated.

Plant-lice.—The fact that plant-lice are not selected by birds has been mentioned in the notes on the pea plant-louse. It was illustrated in the case of a large plant-louse (*Lachnus*) that was noticed on an old willow in the hog-lot gully August 23, 1896. The tree was infested by so many of the insects that its limbs were more or less covered with the honeydew that exuded from their honey tubes, but none of the numerous birds of the neighborhood manifested the slightest interest in the matter.

Locust Leaf-mining Beetle.—In the summer of 1895 a destructive outbreak of the locust leaf-mining beetles (*Odontota dorsalis*) turned all the locusts of the farm as brown as if they had been scorched by fire, ruining the verdure of the river bluff. On July 30, 1895, when adult beetles were swarming on the locusts of the hog-lot gully, catbirds were observed to be spending a good deal of time amid the browned foliage. Thirteen were collected and nine were found to have eaten

the destructive beetles. One bird contained no fewer than 18. From 1896 to 1902, inclusive, the beetles did not again ruin the foliage, though they were present every year, and at times in early summer were so numerous that a scourge was feared. In 1896 the trees farther up the river, however, were turned brown, showing that the escape of those at Marshall Hall was not due to climatic conditions unfavorable to the insects; therefore it is possible that the birds were, at least to some extent, responsible for it. Forty-six birds from the following 21 species, taken during different years, had eaten the locust leaf-mining beetle:

List of birds whose stomachs contained locust leaf-mining beetles.

Catbird.	Red-eyed vireo.	Great crested flycatcher.
Chipping sparrow.	Warbling vireo.	Wood pewee.
Field sparrow.	Yellow warbler.	Phœbe.
Song sparrow.	Orchard oriole.	Yellow-billed cuckoo.
Towhee.	Baltimore oriole.	Cedar bird.
Cardinal.	Scarlet tanager.	Carolina wren.
English sparrow.	Kingbird.	Junco.

Moreover, when most of these birds were collected, the beetles were not numerous. All the common species, especially the arboreal feeders, ate them eagerly whenever they were to be had.

CERTAIN DESTRUCTIVE INSECTS.

Flea-beetles.—Reference has already been made to the injury done to melons by the flea-beetle (*Systena elongata*). Its congener, the pale-striped flea-beetle (*Systena blanda*—fig. 7) is also abundant on the farm and one or the other has been found harmful to corn, melons, and beans. Elsewhere they have attacked fruit trees and tomatoes. Fortunately, however, they appeared to form the natural beetle food of several ground-feeding species of birds and were sought for even when they were very scarce. They were seen in the stomachs of 28 birds, including the savanna, the grasshopper, the chipping, the song, the field, and the white-throated sparrows, the crow, the crow blackbird, the bobolink, the meadowlark, the house wren, and the Maryland yellow-throat. *Systena blanda* was found on ragweed in a field of ripe standing wheat, June 16, 1898. Eleven chipping sparrows that had been flying into the field were shot. None had taken wheat and eight had fed on the beetles, destroying in all 73. The smallest number found in a single stomach was 5, the largest 14.

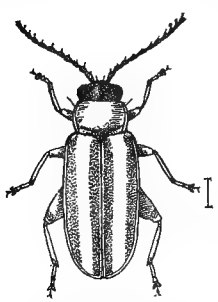


FIG. 7.—Pale-striped flea-beetle (*Systena blanda*) (after Chittenden; loaned by Division of Entomology).

Rose-chafer.—During the last week of May, 1896, the rose-chafer (fig. 8) was present in such numbers that 100 individuals were counted on one rosebush and three times that number on an adjacent blossom-

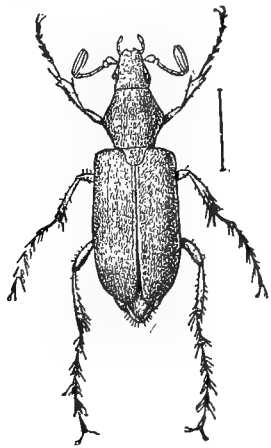


FIG. 8.—Rose-chafer (after Riley; loaned by the Division of Entomology).

ing elder. Of 62 birds collected during this outbreak, only 3—2 kingbirds and a cardinal—had destroyed rose-chafers. This result was not expected, because May-flies and other tempting insects were not com-

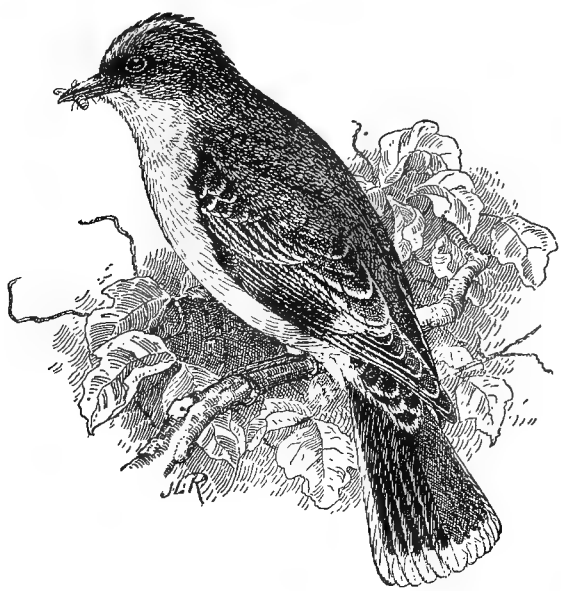


FIG. 9.—Kingbird.

mon then, and because rose-chafers have no disagreeable secretions like those of potato-beetles and the two diabroticas, but are relatives of the May-beetle and the dung-beetles, which are highly relished by

many birds. The kingbirds (fig. 9) had, however, shown a great liking for rose-chafers, as these two, the only ones collected, had eaten 15 and 20 of the insects respectively.

May-beetle.—May-beetles attract only the larger species; their hard shells offer too much resistance to small birds. During their season—May and June—292 bird stomachs were examined, but May-beetles were found in only 16. These stomachs were from birds of the following ten species: Brown thrasher, orchard oriole, phœbe, catbird, gray-cheeked thrush, blue jay, crow, crow blackbird, screech owl, and broad-winged hawk. This record is far below a fair average, for at the time it was made the beetles were rare; moreover, the two famous beetle-eaters, the crow and the crow blackbird, were represented only by a single individual of each kind.

Cutworms.—Similarly unfavorable conditions attended the destruction of cutworms (fig. 14), though these insects are obtainable for a longer period and are edible for small as well as large birds. No serious outbreak of this pest occurred. Had there been one, birds would have been found combating it, for all species that are in the slightest degree insectivorous and feed at all on the ground show a marked liking for cutworms.

Grasshoppers.—Grasshoppers (fig. 10) when abundant are to the bird what bread is to man. They were, however, comparatively rare at

FIG. 10.—Grasshopper (after Riley; loaned by Division of Entomology).

Marshall Hall; therefore only 71 of the 645 native birds collected had eaten them, though most of these had made them the major part of their food. The list of species eating them is as follows:

List of birds examined whose stomachs contained grasshoppers.

Bobwhite.	Orchard oriole.	Cardinal.
Kingbird.	Crow blackbird.	Maryland yellow-throat.
Great crested flycatcher.	Savanna sparrow.	Catbird.
Blue jay.	Grasshopper sparrow.	Carolina wren.
Common crow.	Henslow sparrow.	House wren.
Cowbird.	Chipping sparrow.	Brown creeper.
Red-winged blackbird.	Field sparrow.	Robin.
Meadowlark.	Song sparrow.	Bluebird.

Had grasshoppers been abundant the birds would undoubtedly have destroyed them in large numbers. Their scarcity may possibly be due to the abundance of birds at Marshall Hall.

Ants.—Whenever temperature allowed any insects to occur in appreciable numbers, ants were abundant, and at times they were the most

FIG. 1.—CALAMUS SWAMP, THE HAUNT OF SEVERAL MARSH-LOVING BIRDS.

FIG. 2.—CALAMUS SWAMP IN WINTER, SHOWING HILL TENANTED BY BLUE JAYS, GREAT HORNED OWLS, RED-SHOULDERED HAWKS, AND RUFFED GROUSE.

FIG. 1.—TOBACCO FIELD OF LOT 2, WHERE THE EFFECT OF BIRDS UPON AN UPRISING OF TOBACCO WORMS WAS STUDIED.

FIG. 2.—SWEET POTATOES AND PEAR ORCHARD, WHERE VARIOUS INVESTIGATIONS WERE MADE.

conspicuous of all forms of insect life. Of the 645 native birds collected, 147 had fed on them. Woodpeckers, flycatchers, night-hawks, swallows, catbirds, and white-throated sparrows seemed to have the most liking for them.

A large ant very frequently eaten is a black species, *Camponotus pennsylvanicus*, which during the warmer half of the year is very abundant on tree trunks. Its habits expose it to attack by several kinds of birds. The downy woodpecker was constantly making spirals around the trunks of trees at Marshall Hall in vigilant search for these insects. The catbird was seen feeding on them as they journeyed on the ground from tree to tree. These two birds probably destroy more than any other species, though the sapsucker also appears to relish them. The small species of ants are eaten much oftener than the larger ones, especially at their swarming time. For several days during the middle of April, 1899, great swarms of corn-louse ants (*Lasius*) were taking their marriage flight, and of the 55 birds collected then, mostly native sparrows, 23 had joined in the work of destroying them. This was a valuable service, for destruction of the corn-louse ant is the only effective means of combating the corn louse, which this ant protects and disseminates. Swallows, also, often attack the corn-louse ant. On July 8, 1898, six out of seven rough-winged swallows collected on the farm had fed on it and on little else, one bird containing 40 ants and another 50. At the same time kingbirds, house wrens, marsh wrens, yellow warblers, song sparrows, and chipping sparrows were making inroads on it, though it was much less numerous than during April, 1899. In the late afternoon of July 18, 1898, flying ants of the species *Myrmica scabrinodes*, which, as Prof. S. A. Forbes has shown, injure corn both when it is sprouting and when it is in milk and also foster the corn louse, were so abundant over lots 1 and 2 that their gauzy wings in the level sun rays filled the air with shimmering rainbow colors. Bank swallows were circling among them, close to the ground, making a hearty supper. By crouching low one could see them catch the insects, sometimes within a few feet of one's head. While the flock were feeding, four birds were collected. They had consumed practically nothing but ants and contained, all together, just 200. At this rate, 250 swallows—a fair estimate of the number present—would consume in a single afternoon 12,500 ants. Many other birds were feeding on them, including night-hawks, a single one of which has been known to eat 1,000 at a meal. A house wren, a yellow warbler, a chipping sparrow, and a phœbe, which were collected earlier, had all taken them, but three swifts collected after sunset had not.

On August 5, 1898, *Solenopsis molesta*, an ant injurious to corn and also a household pest, was swarming, and a number of birds were preying on it. In a newly mown timothy field near the cow barn a dozen

chipping sparrows hopped about, springing a foot or two into the air every few minutes to obtain a mouthful. Two strayed off by themselves and made good subjects for observation. In twenty minutes they had eaten 21 ants. Song sparrows and English sparrows were feeding in a similar manner. A kingbird now and then left his station on an apple tree to snap up the prey, and bank swallows and barn swallows skimmed over the fields, gathering in large numbers. Undoubtedly other species were also doing good service.

The total number of native species engaged in the destruction of ants was 39 and included the following list:

List of birds examined whose stomachs contained ants.

Spotted sandpiper.	Towhee.	Worm-eating warbler.
Downy woodpecker.	Chat.	Yellow warbler.
Flicker.	Canadian warbler.	Magnolia warbler.
Kingbird.	Mockingbird.	Black-poll warbler.
Great crested flycatcher.	Catbird.	Prairie warbler.
Phœbe.	House wren.	Oven-bird.
Wood pewee.	Long-billed marsh wren.	Water-thrush.
Orchard oriole.	Cardinal.	Maryland yellow-throat.
White-throated sparrow.	Barn swallow.	Brown creeper.
Chipping sparrow.	Bank swallow.	Carolina chickadee.
Field sparrow.	Rough-winged swallow.	Blue-gray gnatcatcher.
Junco.	Red-eyed vireo.	Gray-cheeked thrush.
Song sparrow.	White-eyed vireo.	Olive-backed thrush.

On August 3 there was a large flight of termites (*Termes flavipes*), commonly known as white ants, pests that tunnel into woodwork. At the lower end of lot 3 fully 200 swallows, mainly bank swallows, with a few barn swallows and white-bellied swallows, were very busy among them. Two birds of each of the first two species and three of the third were found to have eaten together 320.

Weevils.—Sparrows, blackbirds, orioles, and meadowlarks appeared to be the worst enemies of weevils. The orchard oriole had a useful habit of feeding in plum orchards of the Hungerford farm on the plum curculio, which usually ruins seven-eighths of the crop at Marshall Hall. A score of bobolinks feeding (May 17 and 18, 1899) in a wheat field that was just coming into milk were suspected of injuring the grain, and six were shot. None of them had eaten wheat, but all had fed chiefly on a very injurious weevil—the imbricated snout-beetle (*Epicærus imbricatus*). A dozen bobolinks were observed (May 15, 1900) in plants of red clover securing the clover-leaf weevil (*Phytonomus punctatus*). These two weevils are also relished by blackbirds, meadowlarks, crows, catbirds, and other species. Bill bugs (*Spheno-*

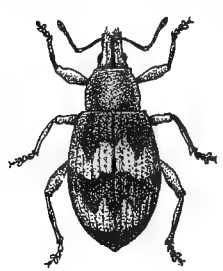


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FIG. 11.—Weevil (after Chittenden; loaned by Division of Entomology).

phorus parvulus) also are often taken, but the small clover weevil (*Sitones hispidulus*) is destroyed most frequently of all. The sparrows and other terrestrial-feeding species and all the aerial feeders consume this little pest in great numbers. The rice weevil (*Calandra oryza*) was found in the stomachs of two marsh wrens collected in the wild rice of the swamp September 7, 1896, and the injurious cabbage curculio (*Ceutorhynchus rapæ*) had been eaten by three rough-winged swallows taken July 9, 1898. Among other weevils destroyed by Marshall Hall birds may be mentioned *Apion*, *Baris*, *Centrinus*, *Macrops*, *Tanymecus*, and *Tyloderma*.

The weevil-eating birds numbered 166 of the 645 collected, and were divided among the subjoined 44 species:

List of birds examined whose stomachs contained weevils.

Downy woodpecker.	Henslow sparrow.	Yellow warbler.
Chimney swift.	White-throated sparrow.	Magnolia warbler.
Great crested flycatcher.	Chipping sparrow.	Black-poll warbler.
Wood pewee.	Field sparrow.	Oven-bird.
Blue jay.	Junco.	Water-thrush.
Common crow.	Song sparrow.	Maryland yellow-throat.
Bobolink.	Towhee.	Chat.
Cowbird.	Cardinal.	Catbird.
Red-winged blackbird.	Barn swallow.	House wren.
Meadowlark.	White-bellied swallow.	Long-billed marsh wren.
Orchard oriole.	Bank swallow.	Brown creeper.
Rusty blackbird.	Rough-winged swallow.	Carolina chickadee.
Crow blackbird.	Red-eyed vireo.	Gray-cheeked thrush.
Savanna sparrow.	Warbling vireo.	Robin.
Grasshopper sparrow.	White-eyed vireo.	

It seems strange that so many birds should have eaten weevils, for the insects were never sufficiently abundant to be conspicuous, seldom, indeed, affording the collector a dozen specimens without diligent use of the sweep net. Moreover, they harmonize so admirably with their surroundings that birds do well to find them at all. Many aerial feeders, it is true, capture them on the wing, but a large number of ground-feeding species take them from the ground despite their protective coloration. The inference is that birds find them dainty morsels, which pay for close seeking. Such a relish is not easily explained, for weevils appear scarcely more edible than little stones; but it is a fortunate circumstance, for they are dangerous pests, not easily controlled by insecticides.

Oak scale.—An unexpected and somewhat suggestive habit discovered at Marshall Hall was the feeding of certain species on scale insects. Of the 22 vireos and arboreal warblers collected during the pine saw-fly invasion previously referred to, 10 had preyed on an oak scale (*Kermes*). This insect does not occur on fruit trees, but its destruction suggested desirable possibilities in cases where scales of

The taste for rose hips, seedy and husky as they are, and often beset with fine bristles which irritate the human skin and would seem really dangerous to internal tissues, is one of the singular freaks of bird feeding. It reminds one of the cuckoo's liking for caterpillars which are so bristly that its stomach becomes actually felted and sometimes pierced by the stiff hairs. Rose hips hang on the bushes throughout the winter, accessible to the hungry grouse as they journey about in the snow for food, and are usually swallowed whole.

The bird likes grapes also. No less than 3.01 percent of the year's diet consists of them, and in November they make 17.2 percent of the total food for the month. All experienced sportsmen know of this taste, and during this month they always count on getting their best shooting in the vicinity of heavily fruited grapevines. The wild grapes with small berries, such as *Vitis cordifolia*, are especially liked, but also large grapes are greatly relished. The species from which cultivated varieties have been derived (*Vitis labrusca*) appears to be commonly selected. Thirty to forty grapes are often swallowed at a meal. From this taste one might expect the grouse to commit depredations on cultivated grapes, but no reports of such damage have come to the Biological Survey.

Like many other birds, the ruffed grouse eats the berries of sumac and other species of *Rhus*. This food contributes 2.46 percent of the year's diet. Among the nonpoisonous sumacs selected are the dwarf sumac (*Rhus copallina*), the staghorn sumac (*R. hirta*), and the scarlet sumac (*R. glabra*). Not uncommonly from 300 to 500 berries of the dwarf sumac are swallowed at a meal. This liking for the dry and apparently nonnutritious sumac is another curious freak of bird appetite. Probably, as with the bobwhite, the seeds are broken up in the gizzard and the inclosed meat, or endosperm, set free for digestion. The immunity of the bird from poisoning by poison sumac and poison ivy, which also it eats, is interesting. That these seeds retain their virulence after being eaten was shown in the case of an investigator in the Biological Survey who was poisoned while examining stomachs of crows that had fed on poison-ivy berries. At times the ruffed grouse eats many of these berries, as proven by one collected by Prof. S. A. Forbes, at Jackson, Ill., December 9, 1880, which had eaten 280 of them. Where grouse are numerous, poison sumac is usually less abundant than poison ivy, and consequently it appears less frequently in stomach examinations. One hundred and sixty poison-ivy berries were taken from the crop of a ruffed grouse shot by Dr. A. K. Fisher at Lake George, N. Y., October 24, 1892.

Miscellaneous fruits amount to 19.03 percent of the annual food. The two favorite kinds are the partridge berry (*Mitchella repens*) and the thorn apple (various species of *Cratægus*), both of which were eaten by 40 of the 208 grouse examined. At least two species

of thorn apple are used for food—the cockspur thorn (*Cratægus crus-galli*) and the scarlet thorn (*C. coccinea*). These apple-like fruits afford a nutritious food. At Peterboro, N. Y., the writer observed grouse coming to thorn-apple trees during November and well into December. That they take large numbers at a meal is shown by an individual obtained at St. Vincent, Minn., which had eaten 38. W. H. Kobbé says that grouse eat with great relish the small wild crab apple of the Northwest (*Pyrus rivularis*).[a] They enjoy cultivated apples, seldom missing a chance at trees on the edge of woodlands. At Chocorua, N. H., in October, 1898, some of the birds killed in old orchards of abandoned farms had fed principally on apples. After thorn apples and partridge berries, a number of other fruits are also staples. The large brilliant clusters of the mountain ash (*Sorbus americana*) are acceptable, and the delicious wintergreen berries, with scarlet skin and snowy pulp, are also relished. The bayberry (*Myrica carolinensis*) is a favorite food wherever accessible. In grouse stomachs one often finds nothing but the little round granules contained in the waxy drupes of this berry. Blueberries also are eaten in large quantities. A bird killed at Chocorua, N. H., July 25, 1892, had eaten a hundred blueberries (*Vaccinium pennsylvanicum*), and one killed at Chateaugay, N. Y., in September, contained about three hundred. The high-bush blackberry and the huckleberry also are eaten, as well as the cranberry. Dr. A. K. Fisher found 21 whole cranberries in a bird shot at Lake George, N. Y., November 2, 1901. The extent to which blackberries are sometimes eaten is shown by the fact that the stomach of a grouse contained about 800 blackberry seeds. Another bird had eaten over a hundred sarsaparilla berries. An explanation of the delicious flavor of the ruffed grouse appears in its varied and highly flavored diet of fruit, herbs, and seeds. In addition to the fruits already noted the following kinds found in the birds examined may be named, though the total number mentioned in this bulletin is probably not a fourth of the complete list of fruits eaten by this bird:

Greenbrier (*Smilax* sp.).
Hairy Solomon's seal (*Polygonatum biflorum*).
Smooth Solomon's seal (*Polygonatum commutatum*).
Blackberry (*Rubus nigrobaccus*).
Black raspberry (*Rubus occidentalis*).
Raspberry (*Rubus strigosus*).
Domestic cherry (*Prunus avium*).
Cultivated plum (*Prunus domestica*).
Wild black cherry (*Prunus serotina*).
Wild red cherry (*Prunus pennsylvanica*).
Elder (*Sambucus canadensis*).
Red elder (*Sambucus pubens*).
Black haw (*Viburnum prunifolium*).
Nannyberry (*Viburnum lentago*).
Withe rod (*Viburnum cassinoides*).
Maple-leaved arrow wood (*Viburnum acerifolium*).

[a] Auk, XVII, p. 351, 1900.

29, 1898) had made the bulk of their food of them. The genus is not exclusively carnivorous, for it has been known to feed on seeds of grasses and weeds, and recently (1900) has been discovered eating strawberry seeds to a harmful extent. One grower at Leechburg, Pa., lost on a quarter-acre patch $350 in three nights through their depredations.[a] The nature of the injury has so far made remedial methods impracticable; consequently the predatory habit of birds is valuable in this case.

There is an increasing tendency to doubt the utility of ground-beetles as a class. A European species (*Zabrus gibbus*) is a notorious grain pest, and an American species (*Agonoderus pallipes*) has recently been ascertained to feed sometimes on newly planted corn. Professor Forbes has shown that the food habits of ground-beetles vary with the structure of their jaws, species with sharp-curved jaws being carnivorous, while those with blunt jaws are decidedly vegetarian. Only a few—probably less than half a dozen—of the Marshall Hall birds examined had destroyed the more carnivorous species. It is probable, therefore, that birds do no appreciable harm in their relation to ground-beetles, but may even do some good by reducing the numbers of such species as have vegetarian habits and occasionally become pests. The following is a list of the different ground-beetles found in the stomachs collected: *Amara*, *Anisodactylus agricola*, *A. rusticus*, *Bembidium*, *Cratacanthus dubius*, *Chlænius æstivus*, *Harpalus caliginosus*, *H. pennsylvanicus*, and several smaller species of *Harpalus*. These had been eaten by 82 birds of the following 35 different species:

List of birds examined whose stomachs contained ground-beetles.

Woodcock.	Rusty blackbird.	Louisiana water-thrush.
Spotted sandpiper.	Crow blackbird.	Maryland yellow-throat.
Bobwhite.	Savanna sparrow.	Chat.
Downy woodpecker.	Grasshopper sparrow.	Mockingbird.
Flicker.	Henslow sparrow.	Catbird.
Kingbird.	White-throated sparrow.	Brown thrasher.
Great crested flycatcher.	Chipping sparrow.	House wren.
Phœbe.	Junco.	Gray-cheeked thrush.
Blue jay.	Song sparrow.	Olive-backed thrush.
Crow.	Towhee.	Robin.
Red-winged blackbird.	Cardinal.	Bluebird.
Meadowlark.	Water-thrush.	

Ladybirds.—The most useful of all beetles are the members of the family Coccinellidæ, commonly known as ladybirds, which with their larvæ are voracious feeders on insect pests. Only three of the Marshall Hall birds—a long-billed marsh wren, a song sparrow, and an English sparrow—were found to have destroyed these valuable insects.

[a] Bull. Cornell Univ. Agric. Expt. Sta., p. 150, 1901.

The particular species eaten was in each case *Hippodamia maculata*. It was not noticeably abundant at the time it was taken, but during August, 1896, it was the most conspicuous insect on the farm. Then, however, it was not molested. Ladybirds of another species (*Coccinella 9-notata*) were very numerous when the pea plant-louse was making havoc, and appeared on every pea vine greedily devouring the plant-lice. It was, fortunately, quite free from attack by birds. Indeed, ladybirds appear to be distasteful to birds. I have offered them to a dozen different caged birds, and they have always been refused.

Flies.—Beneficial diptera, such as the predatory robber-flies and the parasitic tachinid and syrphid flies, are too alert to be caught by any birds except flycatchers and swallows, and even these secure them rarely. During June and July, when robber-flies were plentiful, birds were not found disturbing them. Syrphid flies were so numerous during the last of August, 1899, that several would alight on my camera whenever it was set down, but a score of birds collected then had not made use of them as food.

Bees[a] **and wasps.**—The most abundant and conspicuous of the useful insects are bees and the flower-fertilizing species of wasps. Of the 645 native birds collected only 31, representing 20 species, had eaten bees. It is interesting to note that the offenders were largely either warblers or aerial feeders. The list is appended:

List of birds examined whose stomachs contained bees and wasps.

Chimney swift.	Song sparrow.	Yellow warbler.
Ruby-throated hummingbird.	Scarlet tanager.	Black-poll warbler.
	Purple martin.	Water-thrush.
Kingbird.	White-bellied swallow.	Maryland yellow-throat.
Rusty blackbird.	Bank swallow.	Canadian warbler.
Henslow sparrow.	Rough-winged swallow.	Catbird.
Chipping sparrow.	Red-eyed vireo.	Carolina chickadee.

Practically all the bees eaten were small species of the family Andrenidæ, mainly *Andrena* and *Halictus;* the larger species are seldom taken. During May, 1900, bumblebees and carpenter bees congregated in such numbers around locust trees white with grape-like clusters that from sunrise to sunset a deep, continued hum arose as from a hive; and when fruit trees were in blossom bees swarmed about them also: but in both cases observation failed to discover any consumption of the insects by birds. Blossoming persimmon trees alive with bees were watched for several hours, but only one bird, a hummingbird, visited them.

No arculate wasps, except certain species of the family Scoliidæ, become food for birds; indeed, less than half a dozen of all the birds

[a] Exclusive of the honey bee, which is considered separately (see p. 36).

collected had taken these species. Others, such as *Vespa*, *Polistes*, *Pompilus*, *Pelopœus*, *Monobia*, and *Ammophila*, were collectively abundant on frequent occasions, but so far as observation went no birds preyed on them.

That birds feed extensively on parasitic wasps is indisputable; but the harm thus done is less than might be supposed, for the usefulness of such wasps is in inverse ratio to their size, and birds seldom select the smallest forms, such as Braconidæ and Chalcididæ. Ninety-seven of the Marshall Hall birds, representing the following 36 species, had eaten parasitic Hymenoptera.

List of birds examined whose stomachs contained parasitic wasps.

Bobwhite	Baltimore oriole.	Warbling vireo.
Downy woodpecker	Grasshopper sparrow.	White-eyed vireo.
Chimney swift.	Chipping sparrow.	Yellow warbler.
Kingbird.	Field sparrow.	Magnolia warbler.
Great crested flycatcher	Song sparrow.	Black-poll warbler.
Phœbe.	Scarlet tanager.	Louisiana water-thrush.
Wood pewee.	Summer tanager.	Maryland yellow-throat.
Blue jay.	Purple martin.	Chat.
Bobolink.	Barn swallow.	Redstart.
Red-winged blackbird.	White-bellied swallow.	Catbird.
Meadowlark.	Bank swallow.	Long-billed marsh wren.
Orchard oriole.	Red-eyed vireo.	Olive-backed thrush.

In this mischief the flycatchers are by all means the greatest offenders, the swallows next, and, less generally but still noticeably, the warblers next. Of all the flycatchers the wood pewee appeared to be the most active and persistent in this destruction. Parasitic wasps are not usually so alert and swift as many other insects; therefore they are easy victims. Most of the class are ichneumon flies (Ichneumonidæ—fig. 13). Somewhat more than a fifth of the birds that had taken parasitic wasps, however, had fed on a certain black wasp, *Tiphia inornata*, which is a vigorous enemy of the larva of the May-beetle. These wasps are so common in May and June that it is not unnatural that a good many should fall prey to birds. The only other noticeably abundant parasitic Hymenoptera were some very large braconids

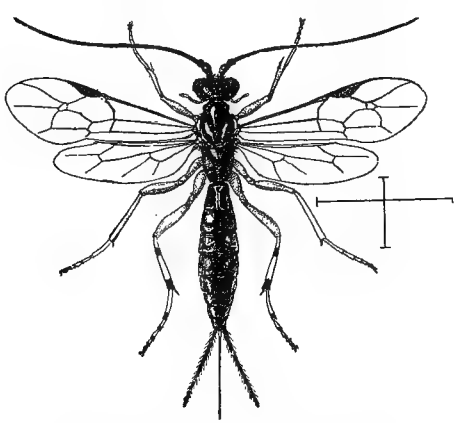


FIG. 13.—Ichneumon fly (after Howard; loaned by Division of Entomology).

(*Melanobracon*), of which at any time during the first part of September, 1896, a dozen could have been collected within a few minutes. Field sparrows and probably other birds consumed them freely, though as a rule parasitic Hymenoptera are eaten only in small numbers.

Many of these useful species appear too late in the season to be of much effect. An attempt was made to measure the evil effects of their destruction by observing how far they were parasitizing abundant insect pests, but conditions were unfavorable and adequate results were not obtained. The white grub of the May-beetle was not present in numbers sufficient to furnish evidence. The tobacco worm was parasitized by braconids to some extent, but even at the time of greatest activity (August, 1898) only one-tenth of 1 percent of the worms were attacked. The question, then, of the degree to which birds offend by preying on these Hymenoptera remains, so far as Marshall Hall is concerned, a doubtful one, especially since most of the species destroyed are not known to be effective parasites.

SUMMARY.

Considering the insect food of the 645 native birds collectively, we find that the birds were most insectivorous in May, when somewhat more than 90 percent of their food was insects, and that naturally they took the fewest insects in the coldest weather. During the blizzard of February, 1900, however, insects constituted 12 percent of the diet of the 37 birds collected. Throughout the entire time of observation insects and their allies, including a small percentage of spiders and other invertebrates, amounted to 60.41 percent of the total volume of food. They are distributed as follows:

Proportion of insects and their allies in food of birds examined.

	Percent.
White ants	1.07
Bugs	3.63
May-flies	6.51
Ants and other Hymenoptera	9.64
Caterpillars, with a few adult Lepidoptera	7.80
Grasshoppers and a few crickets	4.11
Beetles	18.62
Miscellaneous insects	3.72
Spiders	4.48
Miscellaneous invertebrates, mainly crustacea, snails, and myriapods	.83
Total	60.41

The bugs consisted both of Heteroptera and Homoptera. The Heteroptera included such forms as *Podisus*, *Euschistus*, *Trichopepla semivittata*, *Sinea diadema*, *Thyanta custator*, *Hymenarcys nervosa*, *Metapodius femoratus*, *Nezara hilaris*, *Corizus*, *Coriscus*, *Corimelæna*, *Prionidus*, *Alydus pilosulus*, and *Alydus eurinus*. The Homoptera

included leaf-hoppers, scale insects, and an occasional plant-louse and giant water-bug. Of the Hymenoptera the insignificant proportion of 1.89 percent consisted of parasitic wasps, while the remainder was almost entirely ants. The Lepidoptera were very nearly all caterpillars, though moths were occasionally eaten. The caterpillars comprised the smooth forms, oftenest cutworms (fig. 14) and others of the family Noctuidæ, together with some Geometridæ and occasionally an arctiid or a sphingid.

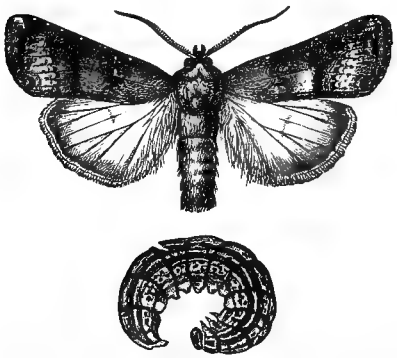


FIG. 14.—Cutworm and moth (after Howard; loaned by Division of Entomology).

The grasshoppers were long-horned grasshoppers (Locustidæ) and short-horned grasshoppers (Acrididæ), the latter consisting of such forms as *Hippiscus*, *Melanoplus atlanis*, *Melanoplus femur-rubrum*, and *Dissosteira carolina*, the former largely of such meadow grasshoppers as *Xiphidium* and *Scudderia*, with an occasional katydid. Beetles formed twice as large an element of food as any other order of insects. Ground-beetles (Carabidæ), generally considered useful, formed 2.10 percent of the food; injurious species, largely weevils (Rhynchophora) and leaf-beetles (Chrysomelidæ), and, to a smaller extent, lamellicorn and longicorn beetles, leaf-chafers, click-beetles, and metallic wood-borers (Buprestidæ), amounted to 13.25 percent; while miscellaneous beetles, largely dung-beetles of the genera *Aphodius* (fig. 15), *Atænius*, and *Onthophagus*, and beetles of a number of other families, such as the Anthicidæ, Bruchidæ, Byrrhidæ, Histeridæ, Staphylinidæ, and Tenebrionidæ, completed the remaining 3.27 percent of the beetle food. The spiders were largely the ground-spiders of the family Lycosidæ. Spiders are said to do about as much good as harm, and are usually regarded as of no economic importance.

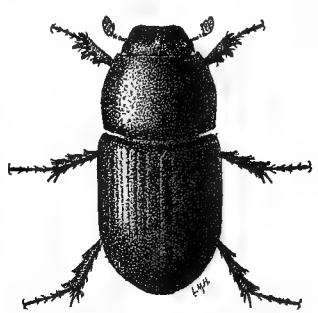


FIG. 15.—Dung-beetle (*Aphodius*) (after Prof. S. A. Forbes).

Beneficial insects (predaceous beetles and parasitic wasps) formed 3.97 percent of the food, while injurious insects, principally caterpillars, grasshoppers, and harmful beetles, amounted to 26.80 percent. It will be remembered, however, that what has already been said about the destruction of useful species shows that but a small fraction of the percentage of these insects should really be counted against the birds.

FOOD OF NESTLINGS.

The largest consumption of insects is to be credited, not to adult birds, but to young ones in the nest. All land birds at Marshall Hall except birds of prey and doves, whatever be their own diet, feed their young chiefly on insects from the time they are hatched until they leave the nest. Many species rear every season two or three broods of from 3 to 5 each, and so voracious are these wide-mouthed youngsters that the parents can supply their wants only by unremitting efforts. Meals often begin before sunrise and continue till after sunset, frequently occurring every two minutes. At first nestlings take considerably more than their own weight of food in a day, and they increase in weight daily from 20 to 50 percent. The number of insects required to supply a season's host of nestlings must be almost incalculable.

Work of other investigators.—One can best study the food of young birds by field observations. Such studies have been pursued by Mrs. Wheelock,[a] Dr. Francis H. Herrick,[b] and Prof. Clarence M. Weed.[c] Professor Weed's bulletin on the feeding habits of nestling chipping sparrows has already been cited at length in Bulletin 15 of the Biological Survey. Dr. Herrick found young cedar birds fed by their parents on grasshoppers, cicadas, chokecherries, raspberries, and blueberries. A brood of red-eyed vireos were given blackberries, red raspberries, bugs, beetles, larvæ, katydids, and grasshoppers. Nestling catbirds were nourished with red cherries, strawberries, larvæ, moth millers, beetles, and dragon-flies (*Æschna heros* and *Libellula pulchella*). Young bluebirds were fed robber-flies (*Asilus*), larvæ, crickets, grasshoppers, and katydids. Mrs. Wheelock states that she observed nestling red-headed woodpeckers eating black beetles; that marsh wrens bring May-beetles to their broods; that young robins are fed moths and dragon-flies, and that crows give frogs and nestling birds (English sparrows, song sparrows, and meadowlarks) to their young.

Methods of investigation.—Mrs. Wheelock's excellent results were obtained in the field by observing the nests *in situ*, and Dr. Herrick's by cutting the nests down and placing them in a favorable situation for observation. Both of these methods have been employed at Marshall Hall. The choice of glasses is important. Mrs. Wheelock used binoculars in studying her subjects. These were used at Marshall Hall with the best success in the case of very active shy birds or those in shadow. A Zeiss monocular 12-power was tried, but was found to be useless unless there was an abundance of strong sunlight, and

[a] Nestlings of Forest and Marsh, 1902.
[b] Home Life of Wild Birds, 1901.
[c] Bull. 55, N. H. Agr. Expt. Sta., 1898.

under any circumstances not so desirable as had been anticipated. A 2-inch telescope with a single draw tube proved much more serviceable. Working with it, however, is very slow and arduous on account of its limited field and the difficulty of changing the focus quickly.

Grasshopper Sparrow.—The difficulties encountered in the use of the telescope in field work may be well shown by a somewhat detailed account of its use in the following instance: On July 9, 1898, a grasshopper sparrow's nest containing four naked young birds was found in a bunch of rabbit-foot clover in a timothy field of lot 1, several rods from the cow barn. The male parent was poised on a weed stalk at no great distance, rattling out his dry ditty, never once stopping to help the mother bird, which was making frequent journeys for food. The latter, on seeing me, perched on a dead mullein stalk 20 to 30 feet away, instead of carrying to her little ones the mouthful she held. The telescope was immediately focused. It enlarged the mother bird so much that she appeared to be peering in at the end of the instrument. The object in her bill was seen to be of a delicate green color, but before further observation could be made she flew to the top of a blackberry bush. Here, by fragmentary glimpses, during which it was necessary to change the focus several times, a narrow wing cover and a long, slim leg were discerned, which showed that the insect belonged to the order Orthoptera (grasshoppers, crickets, etc.). The bird next returned to her perch on the mullein stalk, where she remained long enough to enable the telescope to reveal, projecting from the beak on the side opposite the leg and wing, two filiform antennæ which exceeded the body in length and furnished the necessary clew to the insect's identity as a meadow grasshopper. Further observations were made, with the same interruptions and demands upon the patience. In the next two trips she brought the same insects. She next came with a cutworm, then with a chrysalis, and later with two short-horned grasshoppers (*Melanoplus* and *Dissosteira*). The meagerness of these results, considering the time required for obtaining the information, was due to the restless uneasiness of the grasshopper sparrow and the location of the nest in an open field where no cover for the observer was available to reduce the bird's apprehension. Observation of a house wren (see p. 45) was conducted under more favorable conditions and was much more satisfactory. No nestling grasshopper sparrows were collected at Marshall Hall, but 14 from other localities have been examined, and diagrams that were made of their food and of that of 10 adults taken at the same time show the great importance of insects in the food of nestlings.[a]

Orchard Oriole.—A few observations were made of a brood of well-feathered orchard orioles in a black-walnut tree near the negro cabin,

[a] These diagrams were published in an article entitled The Food of Nestling Birds, which appeared in the Yearbook of the Dept. of Agriculture for 1900.

July 18, 1898. The male parent, a bird in greenish plumage, did not help to provide for the young, but appeared to think that his sole duty consisted in coming to the tree occasionally and singing. The mother worked incessantly. It was difficult to identify what she brought, because she was so shy and remained at the nest so brief a time. I had to stand close to the tree and focus the glass on her when she was nervously hopping from branch to branch. Working under these difficulties I was able to identify but 2 caterpillars, 3 May-flies, 2 short-horned grasshoppers, and 3 meadow grasshoppers.

House Wren.—The most satisfactory and continued observations were made June 17, 1899, of some young house wrens that were about three-fourths grown. In this case it was found desirable to remove the nest, which was in a cavity in a locust tree, transfer it to a baking-powder can, and nail the can to the trunk of the tree about 4 feet from the ground. The following is a detailed account of the feeding:

Feeding of a brood of house wrens.

A. M.	
5.55.	Green caterpillar (*Heliothis dipsaceus*).
5.56.	May-fly.
6.00.	May-fly.
6.02.	Undetermined.
6.05.	*Heliothis dipsaceus.*
(Observations suspended till 7.20 a. m.)	
7.21.	Undetermined.
7.23.	May-fly.
(Observations suspended till 7.45 a. m.)	
7.46.	Harvestman (Phalangidæ).
7.47.	May-fly.
7.48.	Undetermined insect.
7.49.	Undetermined.
7.51.	Undetermined.
7.55.	Undetermined.
7.56.	Undetermined.
7.57.	Undetermined.
7.57½.	Undetermined.
8.00½.	Undetermined.
8.01.	Undetermined.
8.03.	Undetermined.
8.03½.	Undetermined.
8.06.	*Heliothis dipsaceus.*
8.08.	Undetermined insect.
8.11.	Undetermined insect.
8.13½.	Brown caterpillar.
8.16.	Undetermined insect.
8.18.	Undetermined insect.
8.20.	Undetermined insect.
8.22.	Undetermined insect.
8.23.	Two May-flies.
8.24.	May-fly.
8.29.	Brown orthopterous insect.
8.30.	*Heliothis dipsaceus.*
8 35.	Undetermined.
8.38.	Caterpillar.
8.41½.	May-fly.
8.43.	May-fly.
8.45.	Brown caterpillar (cutworm?).
8.46.	*Heliothis dipsaceus.*
8.47.	Undetermined insect.
8.48.	Undetermined insect.
8.49.	Undetermined insect.
8.50.	Undetermined insect.
8.52½.	Cutworm (?).
8.55.	*Heliothis dipsaceus.*
8.56.	Undetermined insect.
8.59.	Pentatomid bug (*Nezara?*).
9.03.	Cutworm (?).
9.05.	Cutworm.
9.10.	Caterpillar (*Acronycta oblinita*).
9.13.	Brown soldier bug.
9.17.	Green caterpillar (noctuid).
9.20.	White grub.
9.25.	Clay-colored grasshopper.
9.25½.	Grasshopper.
9.30.	Undetermined insect.
9.37.	(Two cabbage worms placed on edge of tin can.)
9.38.	*Acronycta oblinita.*
9.39.	*Heliothis dipsaceus.* (Refused cabbage worm.)
9.39½.	May-fly.

Feeding of a brood of house wrens—Continued.

A. M.	
9.45.	Grasshopper.
9.46.	Cutworm.
9.50.	Grasshopper (*Melanoplus*).
9.52.	Saw-fly larva (?).
9.54.	Miller (noctuid).
9.55.	*Heliothis dipsaceus.*
9.57.	*Heliothis dipsaceus.*
10.00.	Spider.
10.01.	*Heliothis dipsaceus.*
10.05.	Black chrysalis.
10.08.	Cutworm.
10.15.	Spider.
10.16.	Caterpillar.
10.20.	May-fly.
10.23.	Spider.
10.26.	Clay-colored grasshopper.
10.29.	Clay-colored grasshopper nymph.
10.30.	*Acronycta oblinita.*
10.35.	Green caterpillar.
10.38.	*Heliothis dipsaceus.*
10.41.	*Heliothis dipsaceus.*
10.46.	Clay-colored grasshopper.
10.48.	Spider.
10.50.	Miller (noctuid).
10.52.	Clay-colored grasshopper nymph.
10.54.	Miller (noctuid).

A. M.	
11.02.	May-fly.
11.02½.	May-fly.
11.15.	Green caterpillar.
11.20.	Miller (noctuid).
11.21.	Black chrysalis.
11.22.	Saw-fly larva (?).
11.25.	Spider.
11.26.	Grasshopper (*Melanoplus*).
11.30.	*Heliothis dipsaceus.*
11.30½.	May-fly.
11.32.	Spider.
11.34.	Grasshopper (*Melanoplus*).
11.34½.	Saw-fly larva (?).
11.36.	*Acronycta oblinita.*
11.39½.	May-fly.
11.47.	Cutworm.
11.48.	May-fly.
11.50.	Cutworm.
11.51.	*Heliothis dipsaceus* (2).
11.59.	*Heliothis dipsaceus.*
P. M.	
12.02.	*Heliothis dipsaceus.*
12.06.	Spider.
12.07.	*Heliothis dipsaceus.*
12.09.	Cutworm.
12.11.	Spider.

The mother wren thus made 110 visits to her little ones in four hours and thirty-seven minutes, and fed them 111 insects and spiders. Among these were identified 1 white grub, 1 soldier bug, 3 millers (Noctuidæ), 9 spiders, 9 grasshoppers, 15 May-flies, and 34 caterpillars. On the following day similar observations were made from 9.35 a. m. till 12.40 p. m., and in the three hours and five minutes the young were fed 67 times. Spiders were identified in 4 instances, grasshoppers in 5, May-flies in 17, and caterpillars in 20.

Previous to the observation of this brood of wrens a collection of adult and nestling wrens was made. Their food is shown in diagrams (Pl. IX, fig. 1).

Barn Swallow.—The food of seven nestling barn swallows (fig. 16) collected June 17, 1899, consisted of beetles (*Onthophagus pennsylvanicus*, *Aphodius inquinatus*, *Agrilus* sp., and Rhynchophora), parasitic wasps (*Chalcis* sp., Ichneumonidæ and *Tiphia inornata*) and flies (Leptidæ, *Chrysops* sp., *Lucilia cæsar* and other Muscidæ), bugs (Capsidæ), May-flies, and snails. The vertebræ of some small fish, which may have been taken to aid the gizzard in digesting the food, were also found in the stomachs.

Bank Swallow.—An examination was made of the stomachs of 83 young bank swallows collected a few miles above Marshall Hall from

a colony in the face of the river bluff. They were probably the progeny of the swallows that frequently circled over the farm. The food of the nestlings and that of adults collected during the nesting season is shown in diagrams (Pl. IX, fig. 2).

Purple martins, which came from a colony of somewhat more than a dozen pairs nesting in boxes on poles at Bryan's Point, a mile above the house, were often seen circling about the farm. On June 28, 1902, I visited the colony and found the parent birds feeding the young soldier bugs, ants, fig-eaters (*Allorhina nitida*), and dragon-flies (*Libellula* and Agrionidæ).

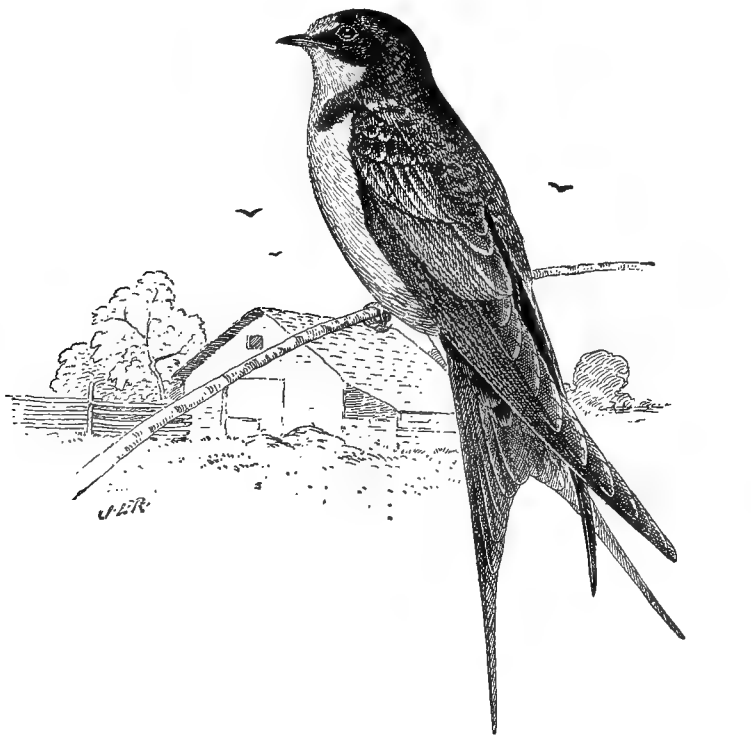


FIG. 16.—Barn swallow.

Three young downy woodpeckers which were collected May 28, 1896, had fed principally on ants, but had also eaten spiders, ground beetles, and caterpillars.

Catbird.—The difference between the food of adults and young belonging to a highly frugivorous species is well illustrated in the case of the catbird, and is shown in diagrams (Pl. IX, fig. 3), which were made principally from results obtained at Marshall Hall.

Crow and Crow Blackbird.—Such granivorous birds as crows and crow blackbirds feed their young mainly insects. Sufficient material

to illustrate this habit was not available at Marshall Hall, but the diagrams here given (figs. 17 and 18), based on results obtained elsewhere,[a] will serve to show it. By the time the young are ready to leave the nest, however, they are fed to a large extent on either grain or fruit, according to locality. In the Middle West they take grain and in the East generally fruit. Both crows and crow black-

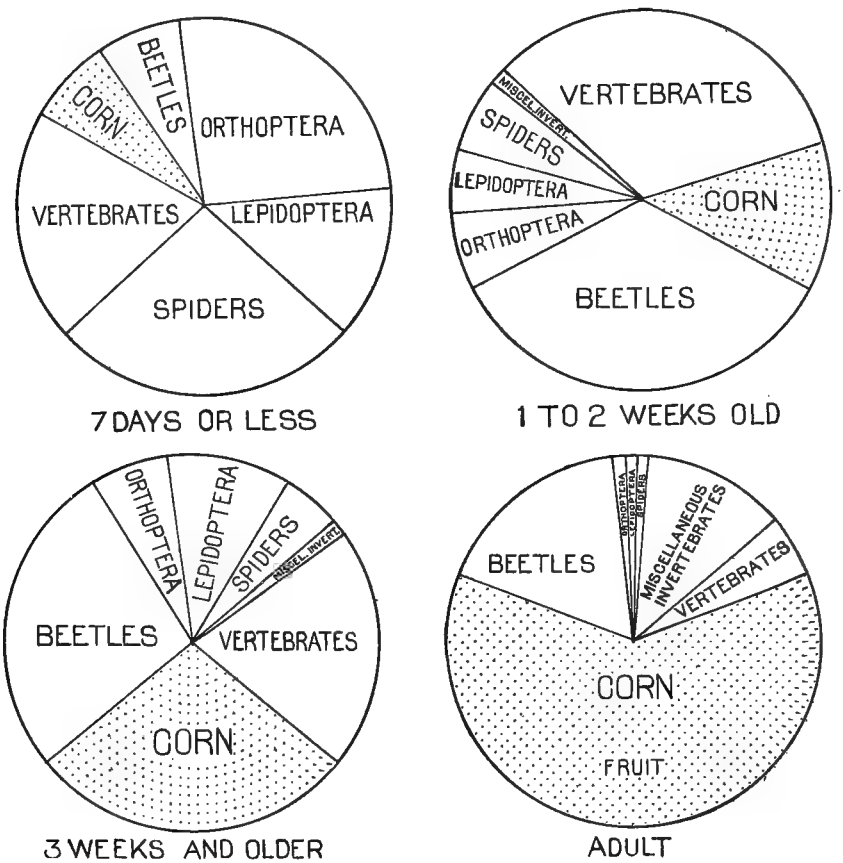


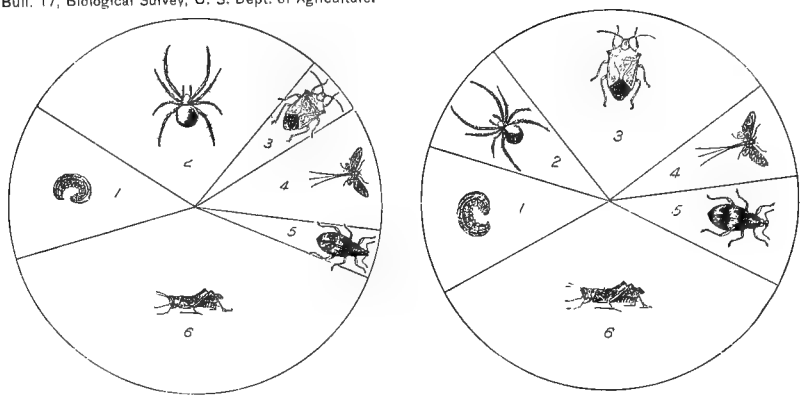
FIG. 17.—Diagram showing proportions of food of American crow (*Corvus americanus*), young and adult.

birds do great service by feeding to their young not only cutworms and grasshoppers, but also large numbers of weevils and May-beetles.

GENERAL REMARKS.

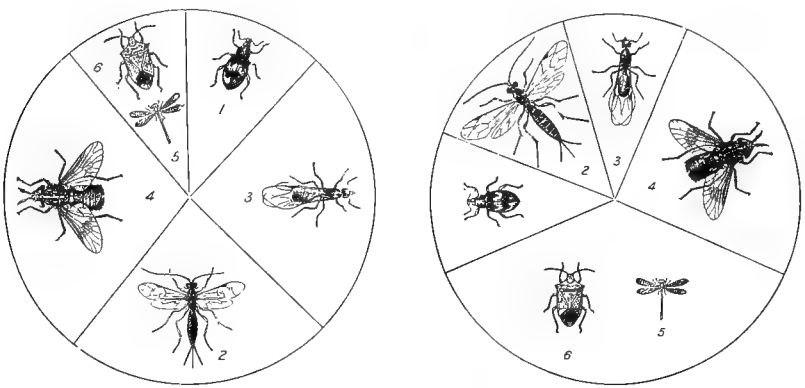
Consumption of caterpillars and grasshoppers is the largest benefit derived from the presence of nestlings on the farm. The parent birds

[a] Most of the stomachs of young and adult crows used in the investigation on which the results shown in the diagram are based were obtained at Sandy Spring, Md.; and most of those of young and adult crow blackbirds came from Onaga, Kans.



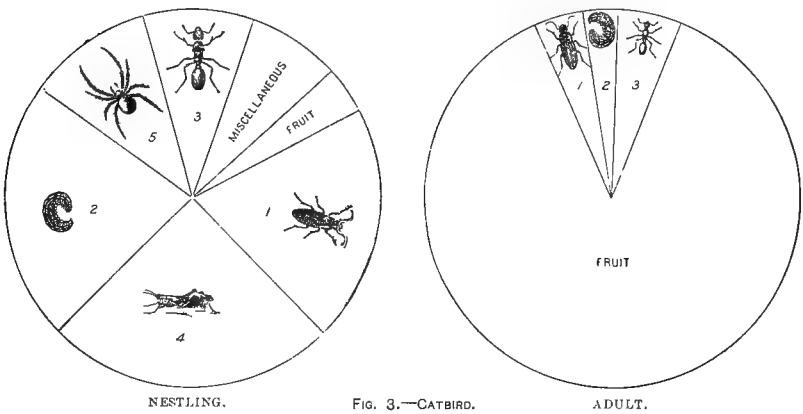
NESTLING. FIG. 1.—HOUSE WREN. ADULT.

[1, Cutworm; 2, spider · 3, stink-bug; 4, May-fly; 5, weevil; 6, grasshopper.]



NESTLING. FIG. 2.—BANK SWALLOW. ADULT.

[1, Weevil; 2, ichneumon fly; 3, winged ant; 4, fly; 5, dragon-fly; 6, stink-bug.]



NESTLING. FIG. 3.—CATBIRD. ADULT.

[1, Ground-beetle; 2, cutworm; 3, ant; 4, grasshopper; 5, spider.]

FOOD OF NESTLINGS AND ADULTS OF THREE COMMON BIRDS.

[The diagrams show the proportions of the various orders of insects in the food, each order being represented by the insect belonging to it that is most commonly eaten by the bird whose food is shown. (In the case of the Hymenoptera a division is sometimes made between the parasitic members of the order, which are very useful, and those that are neutral or injurious. The figures of insects are reduced from cuts kindly loaned by Dr. L. O. Howard.)]

FIG. 1.—RED-TAILED HAWK.

FIG. 2.—SHORT-EARED OWL.

hunt out these insects when they are not abundant and even when they are rare. At the time of the foregoing observations of orchard orioles, house wrens, and grasshopper sparrows, caterpillars and grasshoppers were comparatively scarce; yet the parent birds, though they chose insects for their own eating from more abundant species, hunted far and wide for these rare ones to feed their young. At Marshall Hall

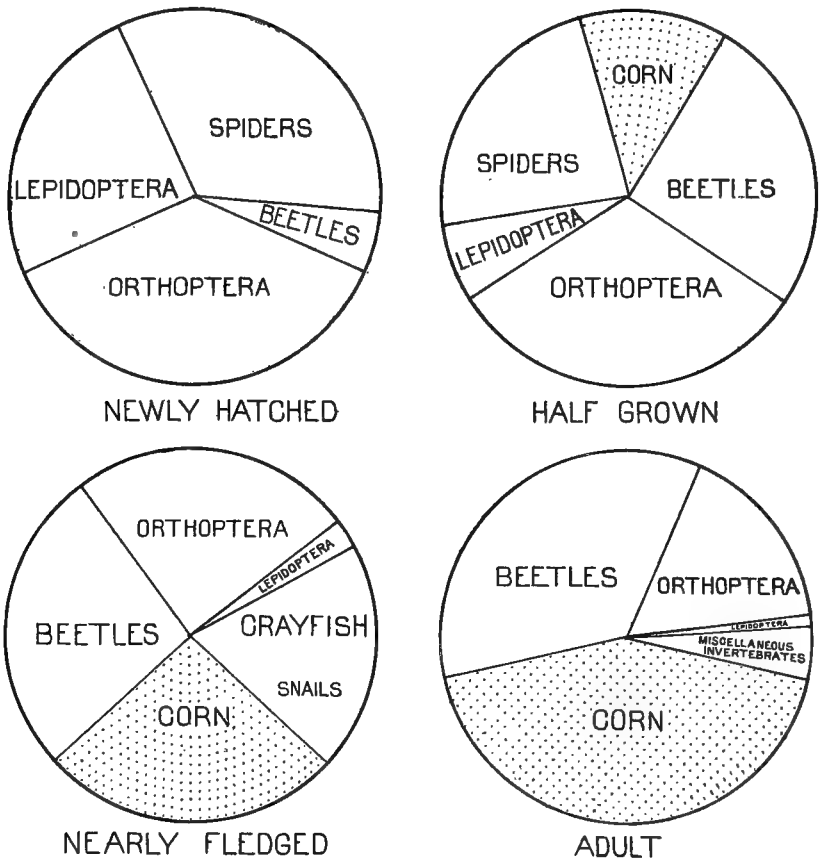


FIG. 18.—Diagram showing proportions of food of crow blackbird (*Quiscalus quiscula æneus*), young and adult.

the protection and encouragement of birds at nesting time is of prime importance. Adults of the most numerous species on the farm are either highly frugivorous or highly granivorous, hence the insectivorous habits of nestlings help considerably to establish the beneficent relation of birds to the farm economy.

III.—VERTEBRATE FOOD.

POULTRY AND GAME.

Crows.—Certain species of the larger birds were found to take vertebrate food. Crows and some of the hawks and owls destroyed useful small birds and also game and poultry. On the Hungerford farm crows were observed killing newly-hatched turkeys, and on the Bryan farm they were not uncommonly seen carrying off little chickens. The most serious offense against the poultry interest, however, was the habitual stealing of eggs. During April, 1900, a crow came every day and robbed a hen's nest in the side of a hayrick at a little distance from buildings. Often he would be seen waiting on a fence near by until the hen announced that the egg had been laid, when he would dash down and make off with his booty. Such depredations could be avoided by furnishing the hens with such facilities that they would no longer lay in exposed situations. As it is, incessant war upon the crow is necessary to prevent heavy loss to poultry on this farm. Game birds also suffer. On May 15, 1900, a crow was caught on the forested slope beyond the swamp (Pl. VII, fig. 2) in the act of pillaging the nest of a ruffed grouse. Crows also despoiled the nest of a bobwhite, a species which probably suffers oftener than the ruffed grouse.

Eagle.—The bald eagles that are frequently seen at Marshall Hall do not disdain to pick up a little game now and then. Early in March, 1897, a crippled scaup duck was seen in the river a hundred yards from the house chased by an eagle and diving every time its pursuer swooped down on it. When the quarry was almost tired out the eagle was shot, and fell into the river with a broken wing, but it had sufficient strength left to lacerate a pointer that attempted to retrieve it. On November 15, 1900, an eagle was seen flying over the house gripping in its talons a live coot, which turned its head rapidly from side to side in its struggles to escape. During the hunting season eagles get a good part of their food by picking up wounded ducks. They also prey on domesticated ducks. In the first week of August, 1896, they carried off several ducklings that went down to the swamp. The royal brigands relish chicken, and in the nest of one pair that came to the farm was the carcass of a recently killed Plymouth Rock hen.

Cooper Hawk.—With the exception of the English sparrow, the Cooper hawk (fig. 19) probably does the least good and the most harm of all the birds of the farm, for it subsists almost entirely on wild birds and poultry. It very frequently steals little chickens, and constantly preys on the bobwhite and useful insectivorous or seed-eating small birds. During November, 1900, the bobwhites were so persecuted that they were seldom found far from cover. In one instance a hawk was seen to swoop to the ground and rise with a victim, the

identity of which was afterwards made sure by the discovery of the feathers of a cock bobwhite on the spot where the hawk had struck.

Sharpshinned Hawk.—The sharpshinned hawk, congener of the Cooper hawk, is also a harmful species. It was frequently observed pursuing native sparrows, and on November 15, 1900, was seen tearing a mockingbird to pieces. The smaller birds suffer most in autumn. On the 15th of November, 1899, I was observing a score of cardinals, juncos, white-throated sparrows, fox sparrows, and song sparrows

FIG. 19.—Cooper hawk.

that were eating ragweed seed in wheat stubble by the negro cabin. Suddenly the whole flock sprang into the air and flew straight toward me and into the bushes behind me, twittering with fright. Their swiftness just saved them from a sharpshinned hawk, which swooped and struck the ground where they had been feeding. It was two hours before they dared to leave their shelter and feed again on weed seeds of the stubble-field. These two species of hawks patrol the farm

so vigilantly in autumn and winter that birds which eat weed seed are kept in constant terror, and are unable to do all the good they might accomplish were it not for their tireless enemies. Owing to the depredations of these two hawks, all hawks without distinction have been relentlessly persecuted by man, although very few are actually detrimental to agriculture.

Great Horned Owl.—Only one of the several species of owls occurring at Marshall Hall is harmful, namely, the great horned owl (fig. 20).

FIG. 20.—Great horned owl.

It occasionally makes inroads on poultry that is not housed. In December, 1897, a great horned owl carried off a full-grown hen from her roost in a tree beside the negro cabin, and on five of the first ten nights of May one came and took hens from the cedar trees behind the house. On the night of the sixth visit a steel trap baited with a hen secured the robber. A year seldom passes without losses from this fierce and powerful bird of prey.

FISH.

Several species of birds on the farm are known to feed on fish, but they are so few in number and take food fishes so seldom that as far as has been learned they cause no material injury to fishing interests, which at this point on the river are of considerable importance. A pair of kingfishers were often seen fishing along the shore in front of the Bryan house (Pl. III, fig. 2), and five nestlings taken from the bluff on the Hungerford place had been fed wholly on fish. Herons, including the night heron, the green heron, and the great blue heron, were frequently seen wading in shallow water, spearing fish with their long, pointed beaks. Two green herons that were collected had eaten silversides (*Menidia notata*) and mummichogs (*Fundulus heteroclitus*). Ducks, particularly the mergansers, feed to some extent on fish. Two hooded mergansers, collected November 15, 1900, had eaten respectively 12 and 20 tiny fish. Gulls are decidedly more piscivorous than ducks. During November the herring gull and the ring-billed gull fished by the dozen out in the river between the farmhouse and Mount Vernon (see Pl. I, frontispiece fig. 2). In the same place the osprey was once in a while seen plunging after his prey. The bald eagle was observed catching fish, but more often it feeds on those that it finds dead.

CARRION.

Some birds, notably eagles, crows, and buzzards, feed at times largely on dead fish. Eagles may be seen along the river scanning the shore for those cast up by the tide. May 19, 1899, an eagle flying over the farm dropped an eel 26 inches long that had evidently been taken as carrion. Gulls, also, undoubtedly pick up a good deal of such food. Crows and buzzards are valuable scavengers of dead fish cast up at low tide during the last of April and the first of May, when the fishing season is at its height. These fish are small, principally sun-fish, white perch, and shad, that were fatally injured by nets. Observations on May 5, 1901, showed the whole river front of the farm strewn with decaying fish, which gave out such a stench that one could not sit comfortably within several hundred yards of the beach. Some 40 buzzards were feeding on the carrion all day. On close inspection they were seen to be selecting that which was most badly decomposed. Crows in almost as large numbers and several crow blackbirds were also feeding, but they commonly took that which was less decayed. Several crows came repeatedly to the shore of lot 1, picked up fish, and carried them to their nests in the woods. By abating this nuisance crows and buzzards do a service that is appreciated by the occupants of the farmhouse.

Buzzards are also useful in removing other carrion. Stock that dies on the farm is never buried, but is left for them. November 16,

1899, some notes were made on the manner in which a carcass was disposed of. On the edge of lot 1, near the mouth of Persimmon Branch, lay a horse that had died two weeks before. Fully 30 buzzards closely attended it, and some were to be found at work on it at any hour of the day, while the others, tired of gorging, sat around on a rail fence, stretching their wings and preening. At night they all roosted together in oak trees within a hundred yards of the horse, as if they wished to keep near the food. A year later another horse was given over to the buzzards. The buzzards did not in either case tear open the skin to expose the large muscles, but if the weather had been hot they might have eaten these as well as viscera. Crows are seldom known to feed on dead stock, but during the March blizzard of 1898 they were almost starved, and resorted with buzzards to a dead cow. Buzzards dispose of the entrails and other refuse of pigs, fish, and chickens, which are thrown to them in a certain place where they have learned to expect it.

MAMMALS.

Mice.—The crow and several other birds of the farm do some good by destroying injurious mammals. In the vicinity of the storage barn a loggerhead shrike was often to be seen. Here it impaled its prey on thorns of the osage orange hedge and on the barbs of a wire fence. In one instance a house mouse was found spitted on the fence. If extended observations could have been made it is probable that mice would often have been found in the larder of this useful little shrike. The crow takes mice at every opportunity. On February 21, 1900, signs of its work appeared near the runways of meadow mice in a wheat-stubble patch of lot 5, in the form of crow tracks in the light snow, holes pecked in the earth, and at one place spatters of blood and tufts of mouse hair. Hawks feed habitually on these mice. In January, 1898, when there were several inches of snow on the ground, a red-tailed hawk (Pl. X, fig. 1) shot in the road by the negro cabin held in its talons the warm body of a meadow mouse. November 15, 1900, a marsh hawk skimming over lot 2 suddenly dived into the brown broomsedge. As it rose it was killed and a meadow mouse dropped from its clutch. In its stomach the head and hind quarters of another were found. This species of hawk is undoubtedly the most useful mouser on the farm and should have due credit, for mice cause much injury there to fruit trees, sweet potatoes, and grain. The short-eared owl (Pl. X, fig. 2) has several times been observed preying upon meadow mice. This bird, the marsh hawk, and the red-shouldered hawk, which are all excellent mousers and rarely attack poultry or birds, are continually made to pay with their lives for the depredations of the real poultry thieves of the hawk and owl tribe—the Cooper and sharp-shinned hawks and the great horned owl. The illustration of a short-

eared owl here given is of a bird that had just made vicarious atonement for depredations on the poultry by the great horned owl.

Rabbits.—The marsh hawk and other large species prey on rabbits. In the last week of December, 1897, a marsh hawk was shot which had just killed one of unusual size. The crow regularly feeds on young rabbits. On March 27, 1901, several crows that were congregated in some grass land at a point 150 yards behind the house were frightened away. An empty rabbit's nest found on the spot and stains of blood on the broom-sedge told what they had been doing. The rabbit is a nuisance on the farm. It often ruins hotbeds of sweet potatoes, cuts tortuous paths through wheat fields, and nibbles cabbages and turnips. Not more than 20 miles from Marshall Hall rabbits girdled and killed 2,000 young pear trees in an orchard of 4,000 within two months.

The food of the 645 birds examined shows only 1.72 percent of vertebrate food. The reason for so small a proportion is the fact that the collection included only 19 birds that could be expected to feed on flesh.

IV.—FRUIT.

CULTIVATED VARIETIES.

Fruit forms with many common birds an important element of food. Of the 645 stomachs of native birds collected at Marshall Hall 139 contained either wild or cultivated fruit. The greatest interest naturally centers in the cultivated varieties.

Strawberries.—The earliest fruit on the farm is the strawberry. It usually ripens about the middle of May and would naturally be expected to tempt the birds. With a view to measuring their depredations on the crop, two visits were made to Marshall Hall between the 13th and the 20th of May of 1899 and 1900. A strawberry patch in the Bryan kitchen garden was watched for several days in the early morning, when birds were feeding most busily, but although catbirds, orchard orioles, and other notably frugivorous species were all around the patch, not one of the birds entered it for berries. On the Hungerford place, adjacent to the wooded dell tenanted by the colony of crow blackbirds already referred to, there was a large strawberry patch, from around which were collected 13 blackbirds, 13 catbirds, and 2 orchard orioles, but only one of them, a catbird, had eaten strawberries. On the previous day the patch was watched for several hours. Only a solitary catbird entered it and he did not take a berry. These and other observations showed that birds at Marshall Hall did not harm the strawberry crop, but, on the other hand, protected it by destroying ground-beetles, which, as has been said, injure the fruit. If catbirds were fond of strawberries, they would have made sad havoc on these farms, for they fairly swarmed amid the

tangled vegetation on the river front (Pl. IV, fig. 1). Their liking for fruit is well known, and it seems strange that they should prefer winter-cured smilax berries to strawberries; yet of 13 individuals collected at this time 5 had eaten smilax berries that had hung on the bushes all winter.

Cherries.—During cherry time 227 birds were collected, 23 of which, comprising crows, crow blackbirds, catbirds, cedar birds, brown thrashers, and kingbirds, had fed on cherries and little else. Cherries ripen from the 30th of May to the 15th of June and remain on the trees for about a month. Some interesting field observations corroborated the results of the examination. On the Bryan farm cherry trees are so numerous that an observer can not keep track of the birds that fly to them, but on the Hungerford farm, where the trees are few, there is no difficulty in taking notes. One large black ox-heart tree in a hedge row several hundred yards from the river was watched June 15, 1899. From sunrise till sunset there was seldom an interval of ten minutes when it was empty. Catbirds flew up to it from the matted vines on the river front; thrashers came from inland thickets; and kingbirds flew over from apple and pear orchards. A flock of half a dozen cedar birds every now and then came to it and fed eagerly, and a crow made it a base of supplies for her greedy brood in a neighboring sycamore. The colony of crow blackbirds that had nested in the adjacent dell were, however, the most regular and frequent visitors. They had taken their recently fledged young to a swamp a quarter of a mile away, and all day long flew back and forth in a 'bee line' between that and the cherry tree, often meeting one another in the journey and sometimes numbering three or four in the tree at one time.

As an experiment looking toward the possible protection of cherries, a screech owl with a clipped wing was placed in a cherry tree near the Bryan farmhouse. Several catbirds that came to pillage made an outcry at first, but soon attacked the cherries, regardless of the owl. An English sparrow, a red-eyed vireo, and two orchard orioles that entered the tree were at first much disturbed, but were all eating cherries within fifteen minutes. Since the screech owl does not feed on birds to a considerable extent, they probably did not recognize in him a dangerous enemy. The presence of a great horned owl or a Cooper hawk would doubtless have had a completely deterrent effect. The cherry crop at Marshall Hall is not marketed, nor is one hundredth of it ever picked; the proportion consumed by birds is, consequently, of no economic importance.

Other orchard fruit.—When the cherry season was over the birds that had shown themselves notably frugivorous were expected to turn their attention to the orchards of plums, peaches, pears, and apples. While these fruits were ripe 161 birds were collected, but not one appeared

to have molested them. Many had taken fruit, but had drawn on nature's supply instead of man's. All the trees in the orchard were watched, but birds apparently did not rob them, a fact in striking contrast with the notorious pillaging by birds in the fruit-growing regions of California. In California birds also do much damage in spring by eating the buds and blossoms of fruit trees, but at Marshall Hall no appreciable loss is caused in this way. White-throated sparrows occasionally feed on buds and blossoms, and on one occasion (April 25, 1901) three of these birds were seen mutilating pear blossoms in the kitchen garden, but beyond this no example of such depredations was observed.

Grapes.—Grapes are not raised for market at Marshall Hall. In the Bryan kitchen garden there is a trellis for family use, but birds did no appreciable injury to the grapes that grew on it.

Tomatoes.—Catbirds were reported to be ruining the tomato crop on the Hungerford farm during the third week of June, 1899. The place was visited and every tomato that had reddened at all was found to have been pecked. The injury was causing heavy loss to the farm, for the fruit at that time brought a high price. The patch was watched for several hours, but not a catbird entered it. Nine chickens, however, stole up from a small house on the shore and went from plant to plant, eating greedily. To make doubly sure that catbirds had no share in the mischief, 15 individuals were collected from the neighboring dell and the bushes about the patch, and examination was made of the stomach contents. No trace of tomatoes was found.

Melons.—The only fruit grown for market that suffered from the depredations of native birds was the melon, and it was attacked by only one species—the crow. In numbers from three or four to a dozen at a time crows began to injure melons about August 1 and continued for three weeks, attacking both watermelons and cantaloupes, but preferring the former. Each crow would peck at a melon a dozen times or so and then pass on to another. If no protective measures had been taken, the crop would often have been a total loss, and in spite of all efforts from 5 to 20 percent of the melons grown at all distant from buildings were punctured (fig. 21). Carcasses of crows, strings with long white streamers attached, an improvised miniature windmill that revolved and struck noisily against a piece of metal, and a bit of bright tin suspended from a string so that it turned with every breath of air and reflected the sun about the field were some of the devices used to frighten the wary and suspicious marauders. In 1873, 1874, and 1875, when the melon crop was so important that 4 or 5 acres, containing from 3,000 to 4,000 hills, were given up to it, the method of protection used in the rice fields of the South was adopted: from sunrise to sunset a negro with an old musket and plenty of pow-

der watched from a brush shelter in the middle of the field and, whenever a crow appeared, frightened it away with a thundering report. If the field was left unguarded for any length of time, the crows were sure to make havoc among the melons. Since they would never come within gunshot if they knew anybody was watching, attempts were made to destroy them by a stratagem; two men would enter the brush house and one of them would soon leave, hoping to delude the crows into thinking that the house was empty, so that they would venture within range of the second man's gun. The plan worked only in the first few trials, however. The farmers at Marshall Hall maintain that crows can count up to three, for they could not be hoodwinked unless three men left the house and a fourth remained to shoot.

FIG. 21.—Melons damaged by crows.

WILD FRUIT.

Wild fruit formed 10.12 percent of the food of the 645 birds collected, and had been eaten by 120. Both examination of stomachs and notes of field work showed how important an element it is in the food supply of many species.

Smilax.—The catbird, which, with the possible exception of the cedar bird, is the most conspicuous frugivorous species on the farm, ate in May, when it arrived from the South, the winter-cured berries of smilax. Out of 13 individuals collected May 17–20, 1899, 5 had made from 15 to 40 percent of their diet on these husks in preference, as has already been said, to the feast spread in the strawberry patch.

During May cedar birds and crow blackbirds also relished them, and the robin, when hard pressed on its arrival, during the last of February, was seen to eat them eagerly.

Mulberries. —The first wild fruit that offers a freshly ripened supply at Marshall Hall is the mulberry, and it lasts from the end of May until the end of June. On May 29, 1896, observations were made of birds feeding in a large mulberry tree in the wooded gully of the hog lot. A pair of downy woodpeckers that bred in a willow stub near by were twice noted eating the berries. A Baltimore oriole, probably a late migrant, fed on them eagerly. Several pairs of orchard orioles and kingbirds which nested together near the house came to the tree at frequent intervals. The kingbirds would balance themselves on the topmost sprays and pluck the berries as gingerly as if they had been insects. Two pairs of red-eyed vireos and a pair of white-eyed vireos haunted the mulberry and adjacent trees, now and then taking a berry, but most of the time apparently eating insects. A cardinal that nested on the shore of the calamus swamp, 200 yards distant, made one trip to the tree, but was accidentally frightened out of any subsequent visits. Crows came from the woods 25 rods away and three blue jays journeyed at least a quarter of a mile for the fruit. Song sparrows frequently hopped about on the ground beneath the tree and picked up fallen fruit. A flock of eight cedar birds fairly gorged themselves. At intervals they would repair to cedar trees on the brink of the gully and sit as motionless as if they were literally stuffed, until digestion relieved their repletion. Then they would apparently wake up, preen their pretty plumage, and, regaining activity one after another, would presently with one accord fly back to the berries with renewed appetite. They appeared to spend their whole time alternately feasting and napping. The catbirds were about as gluttonous, but not so lazy. They came to the tree from the neighborhood, from the house, and from the river bluff. Hardly a period of five minutes passed in which not one was among the branches, and three or four were often present at once. They were so tame that it was possible to see just how they fed. One would pluck a berry, sometimes an inch long, bolt it whole, and then stand almost choking, with mouth wide open, while the berry, which made a great lump in its gullet, slowly passed into its stomach. Then with evident relief it would hop about and perhaps sing a few bars of song. There was no luxurious idleness among the catbirds. As soon as they had eaten they either sang or flew away to resume nest building, incubation, or the feeding of their young. Mulberries formed at this season the greater part of their food.

A list follows of the birds that were observed feeding on this fruit or that were found by examination to have eaten it.

List of birds feeding on mulberries.

Blue jay.	Cardinal.	Downy woodpecker.
Crow.	Carolina chickadee.	Cedar bird.
Crow blackbird.	Song sparrow.	Catbird.
Orchard oriole.	Red-eyed vireo.	Kingbird.
Baltimore oriole.	White-eyed vireo.	Bobwhite.

Raspberries and blackberries.—The black raspberry, the dewberry, and the blackberry, which are the wild fruits that, in the order given, ripen next, are too plentiful and too widely distributed for much remunerative field observation. The following list of birds that ate them was prepared chiefly from stomach examination:

List of birds feeding on raspberries and blackberries.

Bobwhite.	Brown thrasher.	Kingbird.
Summer redbird.	Catbird.	Red-headed woodpecker.
Cardinal.	Orchard oriole.	Cedar bird.
Song sparrow.	Bluebird.	
Field sparrow.	Crow.	

A few field notes on the destruction of these fruits were made, however. Catbirds were seen, May 30, 1896, in black raspberry bushes near the house, eating half a dozen berries apiece. During June, 1899, lot 2 was overrun with a network of dewberry vines. Here, on the 17th, bobwhites were observed walking from vine to vine, picking the berries in a systematic fashion. During 1896 blackberries fruited heavily, and birds were not slow to take advantage of the generous food supply. July 12 a red-headed woodpecker was observed to come and feed on the berries with catbirds and orchard orioles, and a kingbird was seen to fly down to a bush, hover beside it, and pluck a berry. In early August, 1898, two field sparrows were seen in several instances selecting fruit which had dried on the bushes in preference to that which was fresh and juicy. They may have done this to obtain the seeds of the berry and extract their meat. A number of song sparrows picked up blackberries from the ground as they had mulberries. Since this species is often very abundant in cultivated patches of blackberries and takes 10 percent of its food from this fruit in its season, the habit of feeding on fallen berries may be fortunate for the horticulturist. Rubus fruits are not raised for market at Marshall Hall, hence it is unimportant whether the birds eat them or not; if they were, and if there were no other fruit available, the abundant frugivorous birds would probably decrease the profits considerably.

Elderberries.—Elderberries ripen next, usually during the latter half of July. There are so few of them on the farm that the record is scanty, but field notes made August 5, 1898, show how much they are

relished. A large elder bush was watched from 1.40 to 2.50 p. m. The observations may be thus summarized:

Detailed account of birds feeding on elderberries.

1.45: A song sparrow hopped along under the bush and picked up a fallen berry.
1.51: A downy woodpecker alighted on the main stalk and, ascending within reach of a cluster, ate 2 berries.
1.58: A female orchard oriole came and fed.
2.00: A catbird ate several berries.
2.03: A red-eyed vireo took 1 berry.
2.09: A catbird ate 3 berries.
2.11: A pair of red-eyed vireos flew into the bush; one took a berry and scurried away, but the other remained long enough to eat 4 berries.
2.12: A male redbird dashed in, took a berry, and dashed out.
2.13: A crow dropped clumsily into the bush, but after one peck at the fruit espied me and flew away with loud clamor.
2.15: A catbird took 1 berry.
2.16: A white-eyed vireo took 3 berries.
2.20: A catbird took a berry.
2.23: A female summer redbird came shyly and hurriedly ate several berries.
2.24: A catbird took a berry.
2.25: Another catbird picked at a cluster rapidly for one minute, swallowing in that time 20 berries.
2.27: A red-eyed vireo, poised in the air like a humming bird, ate several berries from the same cluster.
2.28: A female cardinal ate a berry.
2.30: A catbird ate 10 berries in a minute, rested, and
2.33: Took several more.
2.35: A female summer redbird, bending a berry stalk under her weight, leisurely plucked 5 berries from the drooping cluster.
2.37: A catbird ate 4 berries, sat and preened its feathers, and
2.50: Ate 17 more.

Wild cherries.—The wild black cherry (*Prunus serotina*) is plentiful at Marshall Hall, but as a rule birds did not congregate about it as they do in more northern States. The following species were found feeding on it:

List of birds feeding on wild cherries.

Catbird.	Song sparrow.	Orchard oriole.
Kingbird.	English sparrow.	Red-headed woodpecker.
Phœbe.	Crow.	

Blueberries.—Blueberries, though a staple article of birds' diet, are so scarce at Marshall Hall as to be unimportant. Tufted titmice and catbirds have been noted feeding on them at the southern corner of lot 4.

Other wild fruits.—With the waning of summer there comes such an abundance and variety of wild fruit that birds scatter over wide areas of the farm, and observation of their feeding habits yields only desultory results. There are, altogether, more than a score of wild fruiting plants at Marshall Hall, which furnish food to at least 30 kinds of

birds. Some of them, such as sassafras, blackberry, elder, and wild cherry, drop their berries shortly after ripening them, while others, such as hackberry, catbrier, and sumac, keep theirs well into winter and even until spring. The bountiful supply of late fruit is most noticeable just after the falling of the leaves. Then one may see large trees festooned with the burdened vines of bittersweet, woodbine, catbrier, and wild grape. Besides the climbing plants, many shrubs and trees are laden with fruit. The low horse-nettle is bright with yellow berries; the rank pokeweed bends under long grape-like bunches of dark purple fruit; and the persimmon is hung with yellow globes. The sour gum has dropped its deep-blue berries and light-red leaves together, but the holly is set thick with scarlet clusters that will glow all winter amid its shining green.

Some of the tastes exhibited by birds in their selection of fruit are interesting and singular. Catbirds and vireos have been known to pass by ripe blackberries and elderberries and choose green wild cherries and sassafras berries. Many birds eat sumac berries, which are practically all seeds and would seem to be about as satisfactory food as so much gravel. Fully a dozen species select the berries of black alder, which are as bitter as quinine. Cedar berries, a favorite food with birds, have an effect on the human system like cantharides, while the berries of pokeweed, nightshade, and poison ivy contain dangerous poisons. If birds are not immune from the toxic effects of these berries, one may question whether they do not take them for stimulation, as man takes tobacco and alcoholic beverages.

Poison ivy is eaten by practically all the frugivorous birds of the farm. A crow that was shot November 15, 1900, had 144 poison-ivy seeds in its stomach. The pokeberry is also a favorite fruit. Mockingbirds and catbirds that were collected had fed on it so freely that their intestines were discolored by its juice. During February, 1900, the snow was stained in several places by bright red spots with a hole in the center an inch or more deep, at the bottom of which was a mass of fruit pulp and pokeberry seeds. These deposits proved to be excreta of cardinal grosbeaks that had eaten the berries, the heat from the droppings having sufficed to melt the hole in the snow. Nightshade berries (*Solanum nigrum*) were eaten by several birds of the farm, especially by the bobwhite. During February and November, 1900, a few sapsuckers, downy woodpeckers, bluebirds, and myrtle warblers, together with dozens of flickers and robins, and scores of cedar birds and purple finches, fed on the spicy, stimulating berries of the red cedar.

Distribution of seeds by birds.—The large consumption of wild fruit results in a wide distribution of seeds, which are voided by birds and germinate where they are dropped. Some observations on crows will

illustrate this dispersion. On November 17, 1899, a large flock on the wing was noticed in the distance, at a point opposite Fort Washington, several miles above Marshall Hall. They came on down the river in a line that at times stretched almost from one bank to the other. When they neared Marshall Hall they circled several times and finally alighted on the shore of the Bryan farm, at the mouth of Persimmon Branch. The flock numbered at least a thousand, and hoarse caws and croaks gave evidence that it was made up to some extent of fish crows. After the birds had remained on the shore fifteen minutes they were put to flight by a farmer's boy, and flew on down the river, lessening to specks, and finally disappearing on the horizon. Going to the place where they had alighted, I found the sandy beach cut up for more than a hundred yards with their tracks. Many led out to the water, and floating black feathers here and there showed where baths had been taken. The most interesting trace of their sojourn, however, was several hundred pellets of fruit material, which they had ejected through their mouths and dropped on the ground. These pellets (fig. 22) were about an inch in length and half an inch in diameter. They were of a deep purplish color, due to the fruit of woodbine, wild grape, and pokeberry, of which they were mainly composed. In 50 pellets collected there were only 11 seeds of other plants—namely, holly, bittersweet, and poison ivy. Pokeberry seeds were by far the most numerous. Mr. A. J. Pieters, of the Botanical Division of the Department of Agriculture, germinated some of them, thus demonstrating the fact that they were distributed uninjured.

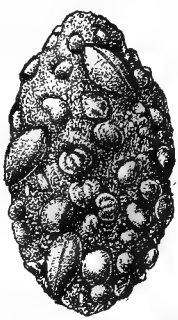


FIG. 22.—Pellet ejected by crow.

Examination of the pellets showed the interesting fact that they were made up not only of seeds (fig. 23) and skin, but largely of fruit pulp in an undigested state; indeed, many pellets appeared to be compacted masses of mashed or squeezed berries. It seems strange that the birds should have rid themselves of a substance that still contained a good deal of nutriment.

Little is known of the distribution of fruit seeds by crows during migration, but it is certain that they do this work effectively while they fly to and from the roosts where they congregate in winter, for their feeding grounds often cover an area stretching out on all sides from the roost for 50 miles or more. It appears highly probable that the crows which are found in winter at Marshall Hall roost at Woodridge, D. C., some 15 miles distant. There, in the midst of several acres of woodland, a crow dormitory is established, in which probably 100,000 crows sleep every winter night. It was visited in February, 1901, and the ground was found to be strewn with disgorged

pellets containing the seeds of poison ivy, poison sumac and other sumacs, smilax, cedar, sour gum, and flowering dogwood. Some pellets, also, were made up of the hulls of corn and oats.

The distribution of fruiting plants illustrated by the crow is effected, though usually in a slighter degree, by all other frugivorous birds. Areas from which such plants and shrubs have been removed are in a short time replanted by birds. At Marshall Hall such plants thus assisted are constantly striving to secure a foothold on the arable land. This scattering of fruit seeds is illustrated by some observations made March 27, 1901. Under a large black walnut tree, remote from other woody vegetation and near the negro cabin, a two hours' search brought to view 172 fruit seeds, including mulberry, cultivated cherry,

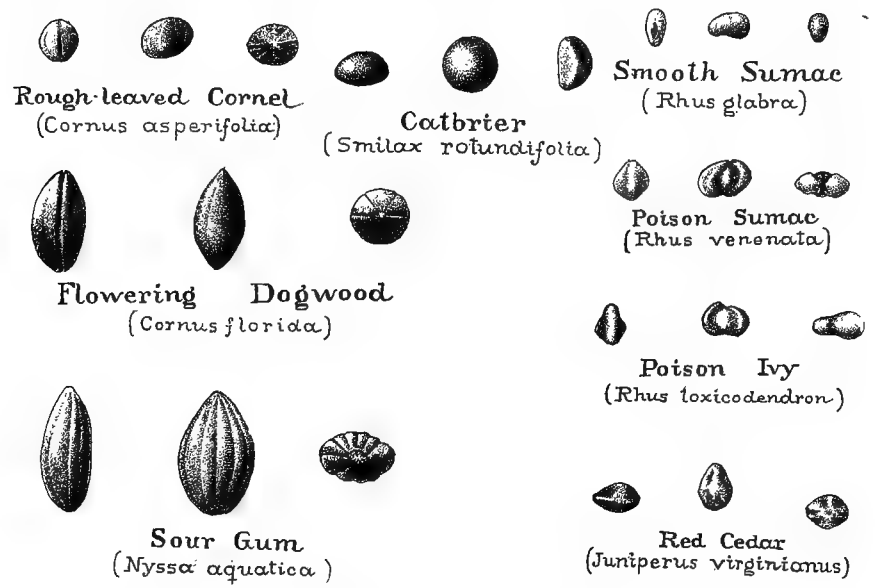


FIG. 23.—Some common seeds found in crow pellets.

wild black cherry, wild grape, woodbine, pokeberry, cedar, sassafras, blackberry, and sumac. Under a large cedar in the middle of lot 2 seeds of the following additional fruiting plants were collected: Elder, hackberry, bittersweet, sour gum, smilax, blueberry, flowering dogwood, and poison ivy.

The most striking examples of trees planted by birds at Marshall Hall are the ox-heart cherry trees that extend along the river front for half a mile. Almost as notable, perhaps, are the tall cedar trees which stand in long rows between adjacent fields (see Pl. XII, fig. 1). Scattered over the old pastures, also, little cedar trees, like fox brushes, attest the work of the winged planters, but in the arable land the rotation of crops kills all except such as may start along fence rows.

FIG. 1.—SASSAFRAS AS A WEED, IN LOT 5.

FIG. 2.—CORN INJURED BY CROWS.

FIG. 1.—CORNFIELD, LOT 5.

FIG. 2.—WHEAT STUBBLE, LOT 3.

The line of trees in the middle-ground marks the course of Persimmon Branch.

Sassafras planted by birds on arable land is not so easily exterminated. On the Hungerford farm it almost choked a peach orchard of several acres. On the Bryan farm it attained such a growth in a cornfield previously used for grass that it had to be cut down with brush hooks (Pl. XI, fig. 1). In another part of the same lot high-bush blackberries sown by birds had to be similarly eradicated.

V.—GRAIN.

Grain had entered into the food of 38 out of the 645 birds examined. Of these 21 had picked up waste kernels and 17 had secured valuable grain, which, however, amounted to but 1.25 per cent of the food of all the birds.

Crow.—The crow (fig. 24) is by all odds the worst pilferer of the cornfield. Every year at Marshall Hall, as elsewhere, a part of the field must be replanted because of his 'pickings and stealings.' In 1899 the replanting was more extensive than usual, requiring on the 39-acre field 1 bushel 2½ pecks, 46 percent of the 3½ bushels originally planted. This unusual ratio was probably caused by the failure of the cherry crop, which left the crow short of food. The protective device of tarring seed corn is employed to some extent on the Hungerford farm. In June, 1899, I planted two rows of corn, one tarred, on the edge of lot 4, near a nest of young crows. When the seed sprouted 3 kernels were pulled from the untarred row, and 7 plants were uprooted from the tarred row, the kernels of which were left intact. On May 30, 1901, a field of sprouting tarred corn on the Hungerford place was visited. In spite of the fact that a field of unprotected corn adjoined it, crows came to this field, perhaps because it was nearer woods. After three of them had walked about among the hills for fifteen minutes the place was inspected. Only three plants had been pulled up, but in each case the grain had been removed. It may be mentioned here that at Wayland, Mass., during June, 1901, crows pulled a large quantity of tarred corn, but did not eat it. The corn there had been coated with wood ashes after the tarring

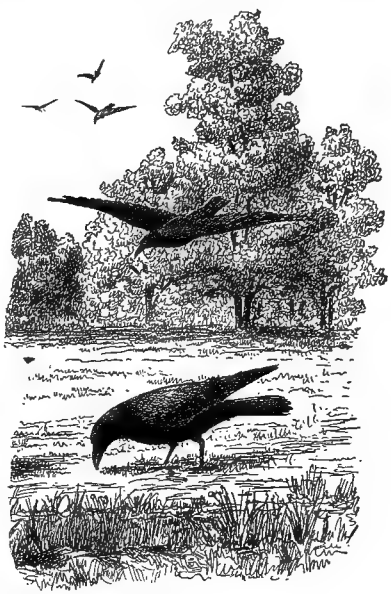


FIG. 24.—Common crow.

and dropped by a corn planter. Some farmers object to tarring for fear of clogging the planter. At Marshall Hall lime is used instead of ashes, but most farmers who tar their corn discard the machine and plant in hills.

The injury to corn by crows at other seasons than sprouting time is, as a general thing, comparatively insignificant, but in some years it has been important when the ears were in the milk. Unfortunately at the worst times no observations were made, though crows were seen each summer feeding on corn in this stage of development, tearing open the ears and picking out the kernels in rapid succession (Pl. XI, fig. 2). In the National Zoological Park at Washington during the summer of 1896, their depredations on an acre of corn in the milk were watched and 50 percent of the crop was found to have been ruined. The only scarecrows that proved effective at Marshall Hall were dead crows and strings stretched on poles around the field and hung with long white streamers. Although in fall the number of marauders is greatly increased by reenforcements from the North, ripe corn sustains less injury than roasting ears. One reason is the fact that the extracting of a few kernels from a ripe ear does not cause the rest to rot, as is the case with roasting ears. Another reason is the abundance of fall fruit. Wheat also suffers comparatively little. When it is ripening, cherries and sprouting corn divert the crows' attention. After it is cut and gathered into the shock, however, they often join the English sparrows in removing the kernels from the cap sheaves. In November, 1899, they attacked newly sown wheat also, cleaning every kernel off a patch of wet ground where the drill had failed to cover the seed. They were also observed in several instances pulling up sprouting wheat. Oats are injured even less than wheat, though crows have been noticed feeding on them at harvest time.

Crow Blackbird.—The crow blackbird (fig. 25) takes grain to the extent of 45 percent of its food, as Professor Beal has shown, and is a bird that needs watching. The farmers at Marshall Hall complained that it injured sprouting corn, but observations did not show the damage to be serious. The only birds concerned in this work were those in the breeding colony in the dell on the Hungerford farm. Except in rare instances, they were not seen visiting the Bryan farm at sprouting time; consequently they could not be held responsible for serious injury there. On May 18, 1899, they were watched in their dell. The parent birds kept going to and from their nests, which held eggs or newly hatched young, and many foraged in an adjacent field of sprouting corn. Nine old birds and four nestlings were collected, but only one, an adult, had taken corn, and that one in trifling proportion. On May 30, 1901, the colony was again visited. The young were then feathered and old enough to eat vegetable food. The most available supply was a field of sprouting corn unprotected by tar, that lay within

a hundred yards of the dell. It was watched from 1 p. m. till 6 p. m., but although the birds often flew over it and in two cases alighted in it, they apparently did it no injury, and a careful search for pulled corn showed not a plant disturbed. Blackbirds probably did some mischief to corn in the milk, however, and were often seen stealing from the shock, but these offenses were trivial in comparison with their attacks on sprouting winter wheat. During November, 1900, a flock of from 2,000 to 3,000 pulled wheat on the Bryan farm, and only continual use of the shotgun saved the crop. At each report they would fly to the oak woods bordering lot 5, where they fed on acorns. Nine birds collected had eaten acorns and wheat in about equal proportions. The flock must have taken daily at least half an ounce of food apiece,

FIG. 25.—Crow blackbird.

and therefore, if the specimens examined were representative, must in a week have made away with 217 pounds of sprouting wheat, a loss that would entail at harvest time a shortage of at least ten times as much. When wheat and oats were harvested no appreciable loss was possible, as only a few blackbirds remained on the farm, and, in fact, these few appeared to be feeding on fruit or insects, or, when they did eat grain, to be taking chiefly waste kernels. During June of 1898, 1899, 1900, and 1901, when wheat was ripening or being harvested, blackbirds came from their nesting dell to the Bryan farm, but only in few instances were they seen in the wheat fields. On June 15 and 16, when oats and wheat were ready to cut on the Hungerford farm, the colony was closely watched. The young were on the wing and the

whole flock was expected to resort to the grain fields, but none were seen to enter them. On June 18, however, when oats were being cut, several birds were noted feeding on them in two instances.

English Sparrow.—The English sparrow (fig. 26) is the most highly granivorous bird on the farm. The stomachs of 53 birds—17 nestlings and 36 adults—were collected. Grain had been eaten by 8 of the young—a large proportion, for nearly all nestlings are almost exclusively insectivorous. It formed 86 percent of the food of the adults, all but two having taken it. Six had selected oats, 14 wheat, and 15 corn. The number of English sparrows on the two farms varied from 200 to 1,000. They fed on grain whenever and wherever it was attainable. They did not appear to hurt sprouting fields, but did considerable harm to standing crops. In 1898 lot 4 was in wheat, and

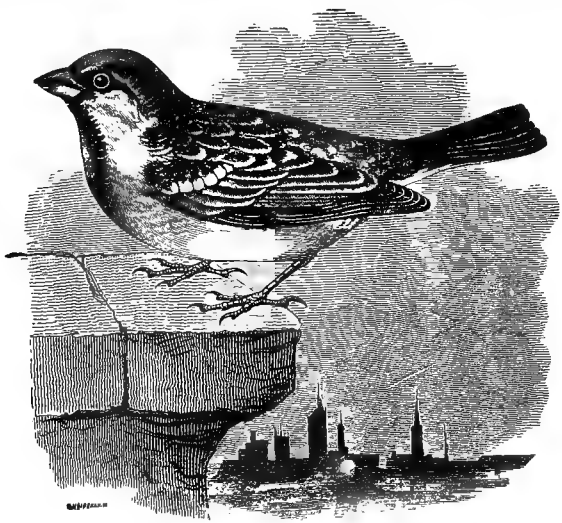


FIG. 26.—English sparrow.

about the middle of June, when it was nearly ready for cutting, a strip 200 yards long beside the fence near the storage barn was found broken down by sparrows. The loss by this mischief was even greater than that by their continual thefts from the rest of the field. A year later they ruined in the same way a strip of wheat several yards wide, extending from the negro cabin to Persimmon Branch, and also sections of oat fields on the upper part of the Hungerford farm. They attacked both wheat and oats in the shock, and stole much of the grain in the cap sheaves. They were seen feeding on corn in the milk, but probably selected ears that had already been torn open by crows; Dr. A. K. Fisher, however, has observed English sparrows at Chevy Chase, Md., opening and eating the tip ends of ears of corn

without any aid from crows. Whenever stock was fed with grain they were always on hand to get their portion. They ate corn with the pigs in the hog lot, and often outnumbered the little chickens in the back yard around their rations of cracked corn or Indian mush. Not satisfied with regular feeding times, they drew on the source of supply, the corn house, and could be seen any day in the year, but most commonly in winter, flying out of it, sometimes by the score.

Other birds.—So far as is known, no other birds of the farm committed serious depredations on grain, though several occasionally did trifling harm. The red-winged blackbird did not disturb sprouting grain, but was seen in the first week of August, 1898, to visit cornfields in flocks of from 12 to 20 and eat from roasting ears. Goldfinches were troublesome in ripening oats on the Hungerford farm during the last week of June, 1899. A flock of a hundred spent most of the day swaying on bending oat stems. Four were collected, but singularly enough no grain was in their stomachs. On an acre of the field where the birds usually assembled, 5 percent of the crop was lost from the breaking down of stalks.

If the mourning dove and the bobwhite do harm to grain it is so slight as to escape notice. The dove, however, has been taken with a few kernels of sprouting wheat in its crop.[a] Both birds eat a good deal of waste grain in stubble-fields. On August 31, 1898, in lot 4, there was a flock of at least 30 doves in the wheat stubble of the Bryan farm, and at the same time there were two smaller flocks on the Hungerford place. In November, 1899, the flock on the upper part of the farm fed with the bobwhites on wheat stubble, and, like them, did not appear to relish corn dropped from the ear in fields where they were searching for weed seed. There was considerable diversity of feeding habits among different flocks of bobwhites on the two farms. One flock on the Bryan farm during November and December, 1900, was seldom seen on a patch of wheat stubble adjacent to their cover, the oak woods of lot 5. Hawks were numerous there, however, and may have frightened the birds away from what would ordinarily have been a tempting feeding ground. A large covey on the lower part of the Hungerford farm, where no wheat had been raised, fed entirely on weed seed, but one at the upper end spent about all the feeding time in wheat stubble. This covey had a habit of sleeping in a peach orchard, as was attested by little rings of dung showing where the birds had squatted in a circle with heads out and tails in. From six of these rings, representing as many days' feeding, 300 droppings were collected. Remains of wheat, or more strictly speaking, fragments of bran from one-fifth of a millimeter to 5 millimeters in length, formed 85 percent of them. A bird of this covey had in its crop 160 whole

[a] In Essex County, N. J., the dove does much damage in newly sown fields of buckwheat.

grains, and in its stomach other wheat half digested, all amounting to 91 percent of its food. The next year bobwhites were noted feeding in wheat stubble in lot 3 (Pl. XII, fig. 2). In November, 1900, observations were made in a cornfield in which the tops of the stalks had been removed for fodder, leaving the ears attached to low stalks. In many places kernels had dropped to the ground, but the bobwhites that frequented the field to procure weed seed apparently did not touch them. These desultory data would seem to indicate that the bobwhite takes only waste wheat and does not relish corn, but observations made in November, 1901, on lot 5 of the Bryan farm, when the corn was in the stack (Pl. XII, fig. 1), does not confirm this supposition; for in this case the birds fed to a certain extent on the waste kernels of corn scattered on the ground.

The meadowlark is much less granivorous than these two species, but it often picked up wheat in stubble-fields just after harvest and late in the fall. One specimen obtained November 29, 1900, contained 70 percent of wheat. The cardinal was occasionally seen feeding on waste wheat and corn along the edge of stubble-fields. The English sparrow, the crow, the crow blackbird, the red-wing, and the cowbird are also stubble feeders. On the 5th of August, 1898, fully a thousand crow blackbirds with a few redwings were noted picking up waste grain in the wheat and oat stubble of the Hungerford farm. If such a horde of these birds were present at harvest time, complaints would be made against them as serious as those now heard from the Mississippi Valley.

During the blizzard of February, 1900, several birds obtained food from the droppings of farm animals. English sparrows and crows were seen picking corn from dung in the hog pen on the Hungerford farm, and meadowlarks, horned larks, doves, and cardinals were noticed taking it from cow droppings in an open pasture.

The native sparrows, unlike the English sparrows, have little or no liking for grain. In a field of wheat on the Bryan farm 5 English sparrows and 19 native sparrows, including song, field, chipping, and grasshopper sparrows, were collected, just before and just after the crop was cut. All the English sparrows were gorged with wheat, but only 2 native sparrows—a chipping sparrow and a grasshopper sparrow—had eaten it, and they had taken only a single kernel apiece. Moreover, when winter wheat sprouted, the hosts of native sparrows from the North that were running over the fields could not be detected doing it any injury.

VI.—WEED SEED.

Weed seed is a staple article of diet for practically all seed-eating birds. It formed 18 percent of the food of the whole number of birds collected, and had been eaten by 162. Lists of these birds and of the 41 kinds of seeds that they selected are appended.

List of weed-seed eaters and weed seed eaten.

SPECIES OF BIRDS WHOSE STOMACHS CONTAINED WEED SEED.

Bobwhite.
Mourning dove.
Horned lark.
Bobolink.
Cowbird.
Red-winged blackbird.
Meadowlark.
Rusty blackbird.
Crow blackbird.
Goldfinch.
Savanna sparrow.
Grasshopper sparrow.
White-throated sparrow.
Tree sparrow.
Chipping sparrow.
Field sparrow.
Junco.
Song sparrow.
Cardinal.
Carolina chickadee.

SPECIES OF WEED SEED EATEN.

Bull thistle (*Carduus lanceolatus*).
Beggar-ticks (*Bidens frondosa*).
Sneezeweed (*Helenium autumnale*).
Ragweed (*Ambrosia artemisiæfolia*, fig. 27).
Giant ragweed (*Ambrosia trifida*).
Sow thistle (*Sonchus oleraceus*).
Dandelion (*Taraxacum taraxacum*, fig. 27).
Wild lettuce (*Lactuca spicata*).
Black bindweed (*Polygonum convolvulus*, fig. 27).
Pennsylvania persicaria (*Polygonum pennsylvanicum*).
Knotweed (*Polygonum aviculare*).
Climbing false buckwheat (*Polygonum scandens*).
Bitter dock (*Rumex obtusifolius*).
Curled dock (*Rumex crispus*).
Sheep sorrel (*Rumex acetosella*).
Crab-grass (*Panicum sanguinale*).
Pigeon-grass (*Chætochloa glauca*, fig 27).
Green foxtail grass (*Chætochloa viridis*).
Broom-sedge (*Andropogon virginicus*).
Sheathed rush-grass (*Sporobolus vaginæflorus*).
Poverty grass (*Aristida* sp.).
Yard grass (*Eleusine indica*).
Bermuda grass (*Capriola dactylon*).
Paspalum (*Paspalum* sp.).
Sedge (*Cyperus*).
Sassafras (*Sassafras sassafras*).
Blackberry (*Rubus villosus*).
Pokeberry (*Phytolacca decandra*).
Partridge pea (*Cassia chamæcrista*).
Sweet clover (*Melilotus alba*).
Tick-trefoil (*Meibomia nudiflora*).
Snowdrops (*Kneiffia fruticosa*).
Chickweed (*Alsine media*).
Amaranth (*Amaranthus retroflexus*, fig. 27).
Trumpet creeper (*Tecoma radicans*).
Yellow sorrel (*Oxalis stricta*).
Rib-grass (*Plantago lanceolata*).
Spurge (*Euphorbia maculata*, fig. 27).

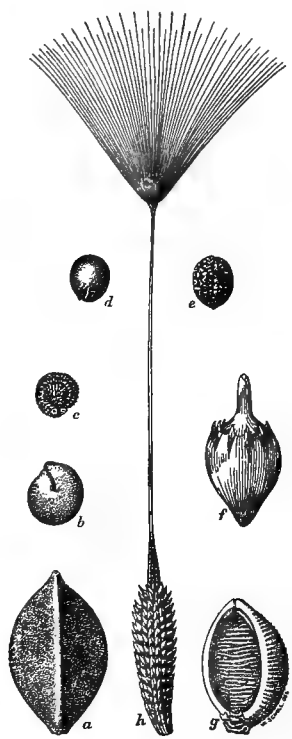


FIG. 27.—Weed seeds commonly eaten by birds: *a*, bindweed; *b*, lamb's-quarters; *c*, purslane; *d*, amaranth; *e*, spotted spurge; *f*, ragweed; *g*, pigeon-grass; *h*, dandelion.

Lamb's-quarters (*Chenopodium album*, fig. 27).
Purslane (*Portulaca oleracea*, fig. 27).
Jewel-weed (*Impatiens*).

WEED DESTRUCTION BY NATIVE SPARROWS.

Spring.—The farmer's strongest allies in his campaign against weeds are the various species of native sparrows (Pl. XIII), which are a potent aid every month in the year, though chiefly in the colder months. The value of their work, obvious in fall and winter, is less easily appraised in spring and early summer, but may be suggested by a few notes.

The sparrows that breed on the farm have to content themselves early in the spring with seeds left from the preceding year, but by the middle of May they find in fields that have lain fallow all winter, or that were in corn the previous season, a plentiful supply of the ripening seeds of chickweed and, a little later, of yellow sorrel. Song sparrows were seen (May 18, 1899) on the edges of such fields helping themselves liberally from opening chickweed pods. Chipping sparrows were noted (May 30, 1896) far out in a patch of corn stubble feeding on yellow sorrel that was going to seed, and a chipping sparrow and a field sparrow collected June 16 and 17, 1898, had eaten seeds of the same weed.

Summer.—During the second week in July, 1898, a song sparrow was often seen following lines of knotweed in the road along the bluff, and a telescope showed that it was plucking off the newly ripened seeds. At the same time another song sparrow, killed on the edge of a timothy field, and two grasshopper sparrows from the center of the same field, had eaten seeds of rib-grass, which at the time was a bad weed in the timothy. During August the seed-eating of sparrows is sufficiently noticeable to attract the attention of even a casual observer, for by this time great stores of weed seed have ripened and the young sparrows, which have been exclusively insectivorous, are ready to take vegetable food. The following notes merely give a few specific cases that might have been multiplied many times every day. A song sparrow was observed (August 28, 1898) picking out soft immature seeds from a spike of green fox-tail grass, a plant that, with its congener pigeon-grass, furnishes seed-eating birds with favorite food. On the same date a score of chipping sparrows were noted amid crab-grass, which was spreading so rapidly through a market garden in a pear orchard on the Bryan place that it was likely to impair the product. They hopped up to the fruiting stalks, which were then in the milk, and beginning at the tip of one of the several spikes that radiated from a common center like the spokes of a wheel and, gradually moving their beaks along to the base, they chewed off the seeds of spike after spike in regular succession. Usually they did not remove their beaks until they reached the base, though some individuals, especially birds of the year, would munch a few seeds in the middle of a spike and then take a fresh one. Fourteen birds were col-

FOUR COMMON SEED-DESTROYING SPARROWS.

1, Junco; 2, white-throated sparrow; 3, fox sparrow; 4, tree sparrow.

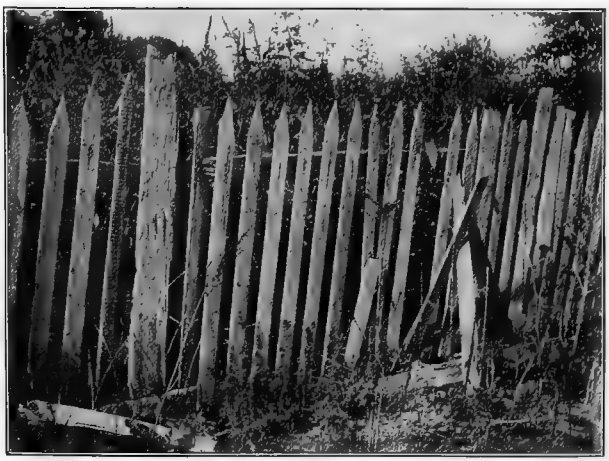


FIG. 1.—GIANT RAGWEED IN GARDEN.

FIG. 2.—BROOM-SEDGE APPROPRIATING LAND.

lected from this orchard and 10 from other parts of the farm. Crab-grass seeds were found to have formed 54 percent of their food, one stomach containing 150 seeds. Most of the remaining 46 percent consisted of such weeds as green fox-tail grass, yellow sorrel, spotted spurge, and purslane, with a very small quantity of ragweed. Other sparrows were found feeding on crab-grass and the foregoing weeds during the last week of August and the first part of September, 1898. It is important to remember at this point that each of the sparrows that live on the farm in summer, namely, the song, chipping, field, and grasshopper sparrows, has its own peculiar habitat, and to note that the consequent diversity of feeding ranges makes their work more or less complementary, hence more valuable.

Autumn to late spring.—From autumn to late spring evidence of the seed-eating habits of sparrows is so plain that he who runs may read. The influx of northern migrants has by this time increased the sparrow population several-fold, and as the leaves have fallen and the crops have been cut, the lively flocks diving here and there among the brown weeds to feed are familiar adjuncts of every roadside, fence row, and field. Sparrows were collected only during November, 1899, February, 1900, and April, 1899. In all, 76 were taken, which comprised 25 song sparrows, 23 white-throats, 12 field sparrows, 11 juncos, 3 chipping sparrows, a grasshopper sparrow, and a savanna sparrow. Seventy percent of their food was weed seed, and the proportion would have been much larger if the birds collected in April could have been taken in March, for they had eaten of the abundant April insects almost to the exclusion of seeds.

Field observations.—The mere examination of stomachs does not give an adequate notion of the extent and the methods of weed-seed eating. It was not feasible to collect stomachs enough to show the characteristics of all the birds of the farm. A few minutes' field observation, however, would often tell what a large flock was doing in cases where it would have been impossible to collect more than a few individuals. Several notes are cited below to illustrate the sparrow's work, which begins, as has already been said, before the seeds are ripe, and continues throughout fall and winter and even far into spring.

In a rank weedy growth of crab-grass and green fox-tail grass in the truck plot of lot 3 a flock of 20 juncos was watched for half an hour, November 15, 1899, as they breakfasted on seeds. At this time most of the seeds had fallen and the birds picked them up under the plants instead of taking them from the stalks as the chipping sparrows had done in August. On the following day the same flock, with about an equal number of white-throated sparrows and song sparrows, flew to the wheat stubble of lot 3, beside the negro cabin, and busily gathered fallen seeds of ragweed which had made a rank growth there.

This weed is troublesome at Marshall Hall; it chokes the crops on truck lands, gains a foothold in pastures, making milk bitter and unsalable, and is so pestiferous in hayfields that it has to be removed by a gleaner. Fortunately, however, it is palatable to seed-eating birds, and it probably furnishes them a larger proportion of their food than any other plant on the farm, a fact which doubtless prevents much greater trouble and loss. Another harmful weed is broom-sedge. It is ruinous to mowing and pasture, and spreads so readily that if undisturbed it would in time take possession of all the fields (Pl. XIV, fig. 2). Juncos, field sparrows, tree sparrows, and probably

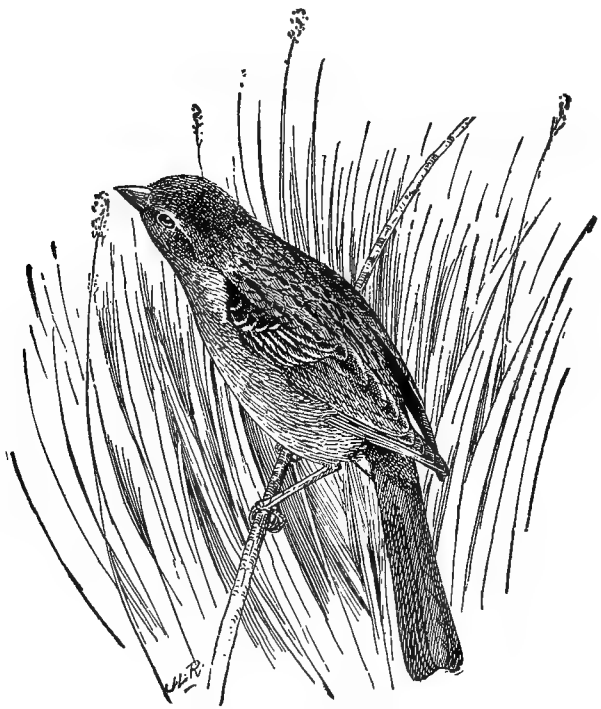


FIG. 28—Field sparrow.

other species check it to some extent. As has been said before, field sparrows and tree sparrows are usually to be found associated with it. In the higher part of the hog lot a flock of field sparrows (fig. 28) during the middle of November, 1899 and 1900, spent most of their time swaying on broom-sedge stalks, from which they were busily extracting seeds. Sometimes a bird alighting on a plant would bend it to the ground and hold it down with its feet while picking out the seeds; seldom would one feed from the ground in any other manner. At the same time a flock of about 30 field and tree sparrows along Persimmon Branch behind the truck plot of lot 3 were also feeding on broom-sedge.

An interesting illustration of tree sparrows' habits was noticed on the Hungerford farm during a heavy snowstorm in the third week of February, 1900. Here and there, where the whiteness of the field was pierced by phalanxes of dry broom-sedge, a flock of a dozen or more tree sparrows found good cheer in spite of the driving flakes. From one brown patch to another they flew, clinging to the plants while they plucked out the seeds, seldom leaving a stalk unexplored. Frequently two would feed from a single stalk, while a third, made thrifty by the wintry dearth, hopped in the snow below searching for scattered seeds. The snow whirled in clouds across the field, but these little creatures, inured to northern tempests, worked on with cheerful, hardy industry. Several days later a flock of more than 200 sparrows, chiefly juncos and tree sparrows, with some song sparrows and white-throats, were observed feeding on a piece of truck land between two bushy brooks where weeds grew rank, in places overtopping a man's head. The snow beneath was everywhere delicately marked with interlacing tracks, which showed how thorough had been the search for food. One space 50 yards square had hardly a square yard that was free from the prints of tiny feet. The main harvest of ragweed seeds lay buried under the snow, but remnants still clung to the stalks, and lamb's-quarters and amaranth were well laden. Under all these plants thickly scattered chaff and seed coats bore witness to the birds' work.

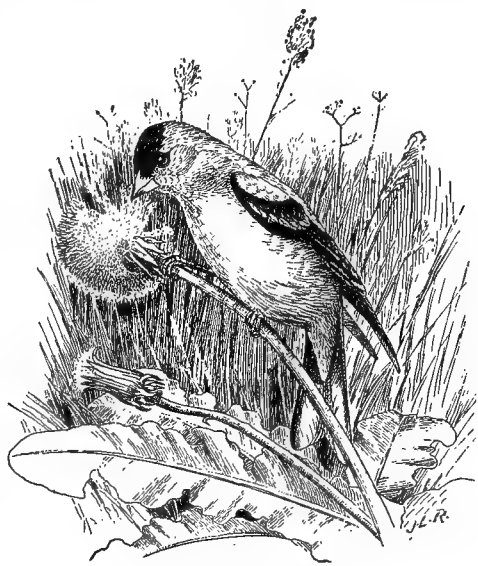


FIG. 29.—Goldfinch.

WEED DESTRUCTION BY OTHER BIRDS.

Goldfinch.—Goldfinches (fig. 29) would be as valuable as sparrows if they were as numerous. Like sparrows, they destroy weeds throughout the year. In spring their first fresh supply comes from the dandelion. On May 18, 1899, three males and two females hopped about among the dandelion globes in the Bryan front yard, every now and then perching crosswise on the stalks and devouring the seeds. In June goldfinches often visited the field daisy (*Erigeron ramosus*), and in July the purple aster (*Vernonia*) and the wild carrot (*Daucus carota*). In these cases they appeared to be picking out immature seeds, and

one bird that was shot contained a soft mass of such food. The habit of feeding on thistles, which has given the species its common name of 'thistle bird,' was well exemplified one day in August, 1898. A thistle on which a goldfinch had been feeding was examined and on its leaves and the ground beneath 67 seeds were counted. They appeared perfect, but close inspection showed a slit through which the meaty kernel had been deftly removed. On the 30th and 31st of August, 1898, the goldfinch was seen eating seeds of the sow thistle and of wild lettuce. September 7, 1896, six birds were banqueting on seeds of beggar-ticks which had appropriated several square rods in an outfield and threatened to give trouble in subsequent seasons. Four youngsters, so recently fledged that they allowed me to approach within 10 feet of them, gave an excellent opportunity (September 21, 1896) to observe how goldfinches feed on ragweed. Often they would all alight on the same plant at once, then they would wrench off the seeds, crack them, extract the meat, and drop the shell, their actions resembling those of a canary at its seed cup. In one instance three alighted on a very small plant, which under their weight bent to the ground. Nothing daunted, they clung to the sprays, heads downward, until they touched the earth, then, shifting their position so as to hold the stems under their feet, went on with their meal.

About the middle of November, 1900, a flock of 300 goldfinches were noted perching in luxuriant ragweed on truck land of the Hungerford farm, industriously stripping off seeds. The work of such an army must have caused decided limitation of the next year's growth. During the third week of February, 1900, a flock of about 50 were seen in a tangle of trumpet creeper on the edge of the bluff (Pl. VI, fig. 1). They were clinging to the long, partly opened pods, extracting seeds, and the refuse of their meal made a continual flurry of floating empty seed wings. During four minutes six birds that were somewhat isolated dropped 57 of these seed wings. Feeding on the trumpet creeper proved to be habitual with the goldfinch and must have prevented many seeds from spreading inland over lot 3 before the prevailing river winds. The plant is a mischievous weed at Marshall Hall. In 1898 it choked out the oats in one part of a patch and twined around nearly half the cornstalks in a field near the river. It was bad in truck plots during 1899 and 1900, and always makes the breaking up of old pastures a serious undertaking for man and horse. It may be mentioned in passing that the downy woodpecker has also been seen picking out these winged seeds, as well as taking mullein and ragweed seeds from the stalk.

Purple Finch.—The purple finch, though it habitually feeds in trees, often destroys seeds of noxious plants. On the 15th and 16th of November, 1900, a thicket of giant ragweed that had made a 10-foot growth in the Bryan kitchen garden (Pl. XIV, fig. 1) was gay with a flock of 30 finches that hung on the sprays while they stripped off the

seeds as the goldfinches had. One bird that was watched with a glass ate 15 seeds in three minutes.

Chickadee.—The Carolina chickadee, though largely insectivorous, was also frequently seen hanging head downwards in ragweed plants wrenching off seeds.

Cardinal.—The cardinal, when observed on arable land, was a denizen of hedgerows. It was not abundant like finches and sparrows, but was not uncommon in loose flocks of ten or a dozen. In company with sparrows it often foraged a little way out from cover for the larger weed seeds, and was seen picking up seeds of both small and giant ragweed. It has a peculiar habit, shared by the fox sparrow, and seen sometimes in the song sparrow and the white-throat, of cracking and eating the seeds of berries and other fleshy fruits; a habit probably useful, especially when seeds of the blackberry and other fruiting plants that invade cultivated land are selected.

Blackbirds.—The large flocks of crow blackbirds on the farm, often numbering from 2,000 to 3,000, have been previously referred to. If they were not notorious grain thieves they would be famous weed destroyers. Even as it is they were sometimes seen eating weed seeds, and in spring, when grain is lacking, they probably do considerable good. During fall and spring of the years 1899, 1900, and 1901, flocks of from 50 to 100 cowbirds, and often several hundred red-winged blackbirds, and occasionally as many as a thousand rusty blackbirds, assembled on the farm. They fed on ragweed of wheat stubble and among weeds of truck areas, and doubtless destroyed an incalculable number of seeds. The cowbird and the red-winged blackbird, according to Professor Beal, feed on weed seed to the extent of more than half their annual food and during most of the colder half of the year at least four-fifths.

Meadowlark.—The meadowlark, though it gets two-thirds of its living from insects, has in the colder months a voracious appetite for seeds. On the Hungerford farm in November, 1899 and 1900, were two flocks of meadowlarks, and on the Bryan farm a single flock somewhat scattered, numbering altogether about 50 individuals. They usually divided their time among the weeds of cornfields both old and new, the ragweed of wheat stubble, and the miscellaneous weeds of truck land. On one occasion birds were seen eating seeds of pigeon-grass in the last situation, and on another picking up seeds of ragweed.

Mourning Dove.—After the breeding season there were three flocks of doves and three of bobwhites distributed like the meadowlarks. Each flock of doves contained between 20 and 30 individuals. One, on the Bryan place, fed in weedy old cornfields, and, after the wheat had been harvested, amid the ragweed of wheat stubble, which by August was 18 inches high. A bird killed from this flock had eaten, in addition

to other food, seeds of yellow sorrel, spotted spurge, crab-grass, and pigeon-grass. Another, on the upper part of the Hungerford place, foraged in the ragweed of wheat and oat stubble, and in a heavy crop of crab-grass and pigeon-grass in a cornfield that was being harvested. The stomach of one of these birds, taken November 17, 1899, contained 150 ragweed seeds, and another 300 crab-grass seeds. The third, on the lower part of this farm, were not seen in stubble-fields, but frequented forests of weeds in certain orchards and truck plots, and apparently made their whole fare on the seeds. During the heavy snow of February, 1900, doves fed in a wind-swept pasture, sometimes appearing to pick up weed seeds, and sometimes assembling in two pits 10 feet in diameter and 6 feet deep, where abundantly fruited plants of pokeberry were growing. At five different times the flock, numbering more than 20, was flushed from the pits. Footprints and red stains on the snow showed that they were eating berries and probably their seeds, some of which were found on the ground after the snow had melted. Fruit-eating birds, which take the berries of this plant, void the seeds uninjured and thus disseminate them, but doves grind them to atoms by the powerful action of their gizzards.

Bobwhite.—One covey of the bobwhites, which has already been described as feeding largely on wheat in its season, lived on the upper part of the Hungerford place; another, still larger, which to judge from its droppings took practically no grain, lived on the lower part; and a third lived on the Bryan farm. One bird from the first covey, 7 from the second, and 5 from the third were shot and examined. These 13 had taken weed seed to the extent of 63 percent of their food. Thirty-eight percent was ragweed, 2 percent tick-trefoil, partridge pea, and locust seeds, and 23 percent seeds of miscellaneous weeds, such as pigweed, sheep sorrel, Pennsylvania persicaria, climbing false buckwheat, trumpet creeper, paspalum, jewel-weed, and pigeon-grass. Though the stomachs and crops were not well filled, the birds had eaten 5,582 weed seeds. One crop contained 400 pigweed seeds, another 500 seeds of ragweed. The latter seeds, which are cracked open by most birds, are swallowed whole by bobwhites and doves, in spite of the spiny processes which beset them. One bobwhite, in addition to other food, had consumed 550 seeds of sheep sorrel; another 640 seeds of pigeon-grass; and several 50 to 100 seeds of jewel-weed.

Extent of weed-seed destruction.—Inspection of an acre of truck land between two converging bushy brooks on the Hungerford farm (November 16, 1899), gave a very satisfactory idea of the autumn work of weed-destroying birds. Crab-grass and pigeon-grass formed a low undergrowth, while lamb's-quarters, pigweed, and giant ragweed from 6 to 10 feet high rose in a thick weed forest. A flock of 15 quail foraged in the center of the area, 25 doves were scattered over the upper end, and fully 200 native sparrows scurried about at the

lower end, while a band of 300 goldfinches clung to the ragweed stalks plucking off seeds. If we make the fair assumption that the birds remained on this acre of plenty long enough to obtain a full meal, we can reckon approximately the destruction wrought. At a moderate estimate 20 seeds apiece may be allowed for the goldfinches, 100 for the sparrows, providing that they were from crab-grass or pigeon-grass, and 500 for the doves and bobwhites, or a total of 46,000 seeds destroyed at a single breakfast.

In the last week of April an attempt was made to ascertain what proportion of the weed seeds ripening on the farm had been consumed during the previous half year. In the wheat field of lot 4, where at the beginning of October there had been scores of seeds on every ragweed plant, it was difficult to find in a fifteen-minute search half a dozen remaining. In the truck plot of lot 3, which had borne a thick growth of pigeon-grass, examination of an area where there had been hundreds of seeds the autumn before would sometimes fail to disclose one, and in a mat of crab-grass in the same field frequently not one was left out of a thousand present in October.

VII.—SPECIES.

Having discussed under the heads of insects, flesh, fruit, grain, and weed seed the elements that entered into the food of the birds at Marshall Hall, we may now enumerate the birds themselves and indicate as far as possible the economic status of each with reference to this particular farm.[a]

WATER BIRDS.

The data concerning water birds are so limited as almost to preclude anything more than a list of species.

GREBES.

The horned grebe (*Colymbus auritus*) has been noted on the river at Marshall Hall in December on two occasions. A pied-billed grebe (*Podilymbus podiceps*) was diving in the bay where the shore curves up to the calamus swamp December 12, 1900 (Pl. III, fig. 1). During November and December as many as a dozen grebes may often be seen on the Mount Vernon flats, on the Virginia side of the river. Grebes feed much less on fish than is popularly understood, and probably do little harm to fisheries. The large proportion of vegetable matter in their food renders them excellent eating, the flesh resembling that of the adult pigeon in taste. They are difficult to secure, however, as their diving habit protects them from all but the most persistent gunners.

[a] Whenever lists of species of birds are given the figure placed after a name indicates the number of stomachs of that species which were examined.

LOONS.

The common loon (*Gavia imber*) and the red-throated loon (*Gavia lumme*) have been noted at Marshall Hall by Mr. William Palmer.

MURRES.

The Brünnich murre (*Uria lomvia*) has been noted at Marshall Hall by Mr. William Palmer.

GULLS AND TERNS.

The herring gull (*Larus argentatus*) and the ring-billed gull (*Larus delawarensis*) occur on the river in the colder half of the year. During March and the first half of April it is not uncommon to see from a dozen to twenty gulls floating between the farm and Mount Vernon (Pl. XVII, fig. 2), apparently busy fishing. The common tern (*Sterna hirundc*) and the black tern (*Hydrochelidon nigra surinamensis*) have also been noted at Marshall Hall.

DUCKS, GEESE, AND OTHER WATER FOWL.

The following species of water fowl were noted on the river at Marshall Hall:

Red-breasted merganser (*Merganser serrator*).
Hooded merganser (*Lophodytes cucullatus*), 2.
Mallard (*Anas boschas*).
Black duck (*Anas obscura*).
Baldpate (*Mareca americana*), 1.
Green-winged teal (*Nettion carolinensis*).
Blue-winged teal (*Querquedula discors*).
Shoveller (*Spatula clypeata*).
Pintail (*Dafila acuta*).
Wood duck (*Aix sponsa*).
Redhead (*Aythya americana*).
Canvasback (*Aythya vallisneria*), 1.
Scaup duck (*Aythya marila*).
Lesser scaup duck (*Aythya affinis*), 1.
Golden-eye (*Clangula clangula americana*).
Buffle-head (*Charitonetta albeola*).
Old-squaw (*Harelda hyemalis*). Noted by Mr. William Palmer.
Canada goose (*Branta canadensis*).
Whistling swan (*Olor columbianus*), 1.

Ducks were so abundant here before the civil war that they were regularly counted on for the larder. As late as 1864 and 1865 it was not uncommon in November to find a flock of 150 scaup ducks in the little bay by the calamus swamp, and in the same place ten years earlier as many as 15 canvasbacks were killed at a shot. It is now rare for half a dozen ducks of the commonest species to settle in the bay. Across the river on the Mount Vernon flats (Pl. XVII, fig. 2), where there is an abundance of wild celery (*Vallisneria spiralis*), flocks of from 25 to 200 ducks are occasionally seen, but they are so continuously fusiladed from launches that run down from Washington and Alexandria that they are soon killed or driven away. Much worse slaughter is wrought by the 'big' gun at night or in the early dawn. These 'big' guns are in reality cannon mounted in gunning skiffs.

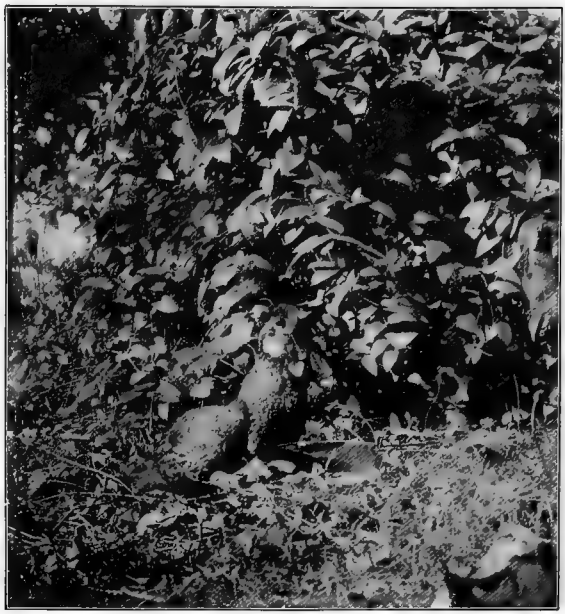


FIG. 1.—BOBWHITE.

FIG. 2.—WOODCOCK.

FIG. 1.—BROOM-SEDGE OF LOT 2, FREQUENTED AT NIGHT BY BOBWHITES.

FIG. 2.—PARTRIDGE PEA OVERSPREADING PASTURE OF LOT 4, EATEN EXTENSIVELY BY BOBWHITES.

The pines in the background were defoliated by the pine saw-fly in the spring of 1900.

They are loaded with a pound of shot that kills at 200 yards or more. The use of the big gun is unlawful, but duck pot hunters have often eluded the authorities by throwing the gun overboard, having previously attached a string and a large cork, so as to insure subsequent recovery. Shooting from launches, which is also frequent and very destructive in this vicinity, is against the law in many places, and should be generally prohibited.

The stomach of a baldpate that was taken March 22, 1902, contained only sprouting wild rice and the stems of some aquatic plants. Two hooded mergansers collected November 15, 1900, had fed exclusively on small fish. A lesser scaup duck taken on the same day had eaten the claw of a blue crab and 75 snails (mostly *Amnicola altiles*, with a few *Goniabosis virginicus* and *Planorbis albus*). The stomach of a canvasback killed the day previous contained 100 seeds of bulrush (*Scirpus*). A whistling swan killed November 16 had in its stomach one bulrush seed and a mass of wild celery leaves about as large as the ball of a man's thumb. The latter plant is abundant in shallow water about Marshall Hall, and gives the characteristic flavor to canvasbacks and other water fowl that feed on it.

HERONS.

The following herons were noted:

Least bittern (*Ardetta exilis*).
Great blue heron (*Ardea herodias*).
Little blue heron (*Ardea cærulea*).
Green heron (*Ardea virescens*), 2.
Black-crowned night heron (*Nycticorax nycticorax nævius*), 1.

The last three species eat fish extensively, but also take other food. One of two green herons that were collected contained, besides fish, a large spider, a giant water bug (Belostomatidæ), and 20 dragon-flies (Agrionidæ).

RAIL.

The toothsome little sora rail (*Porzana carolina*) is found during August and September amid the wild rice of the calamus swamp. The stomach of one, when examined, contained 200 wild rice seeds.

COOT.

The coot (*Fulica americana*) eats mainly wild celery, pond weed (*Potamogeton*), and other vegetable food, and is not to any marked degree piscivorous, as has been shown by the examination of stomachs. It is frequently caught at Marshall Hall in fishermen's nets. A coot was shot on November 2, 1901. It had been feeding on wild celery tubers or stolons, and in consequence had a most delicious flavor. It was perhaps not quite equal to the canvas-back, but was certainly not inferior to the redhead. The coot should in time take the place on

the table of ducks and other waterfowl that are fast becoming exterminated. Coots may be bought in Washington at the rate of three for 25 cents, while canvas-backs in good condition can not be had for less than $3 a pair.

Dr. B. W. Evermann, who has recently made a careful study of the coot, says:

> I have been very much interested in the coot as an article of food. The opinion of those who have put themselves on record in the books is almost unanimous that the coot is worthless as food. And inquiry among my ornithological friends here in Washington resulted in my finding only two or three who had ever tasted coot. The majority of them seemed to regard eating coot very much as we regard eating crow—a thing not to be thought of!
>
> But my friends Dr. Fisher and Mr. William Palmer admit that they have eaten coot and like it. They even say they regard coot as not at all inferior to the famous canvas-back duck, and in this I agree with them fully. Coot, particularly young ones, skinned and fried, or even old ones parboiled, then baked, are quite as delicious as any duck I ever ate.
>
> It is, however, doubtless true that the delicacy of flavor, not only of the coot, but also of the canvas-back and all other ducks, is largely determined by the kinds of food they get. The wild celery (*Vallisneria spiralis*) is sufficiently abundant in Lake Maxinkuckee to give to the coot frequenting that lake a delicate flavor which has received high praise from all who are familiar with it.[a]

SHORE BIRDS.

Woodcock (*Philohela minor*, Pl. XV, fig. 2) are not uncommon at Marshall Hall. On both the Marshall Hall and Hungerford farms there are wooded dells of less than an acre in extent containing small, sluggish, marshy streams communicating with the Potomac. In these places during July woodcock are always to be found. They do not feed much in the dells, but at dusk forage out in the neighboring cornfields, and so destroy harmful insects. Thus, one bird, shot June 26, 1899, in this spot, had eaten wireworms and cutworms in addition to earthworms, fly larvæ, and May-flies. At the junction of two bushy brooks on the lower part of the Hungerford place, woodcock occur in the fall, and one collected November 15, 1900, had in its stomach two beetle larvæ, one grape seed, and two seeds of bastard pennyroyal.

Just below the Hungerford farm is a wooded swamp of a dozen acres where woodcock are also to be found. It is impossible to penetrate into this swamp more than a few rods without sinking to the knees in a black ooze composed of decayed vegetation. Woodcock are not found in this soft morass, but are confined to the edges and along a tiny alder-fringed stream which issues from a spring at the head of the swamp. A favorite feeding ground, located where this stream enters the forested body of the swamp amid elders, magnolias, ashes, willows, and maples, was inspected in July, 1902, and in an area

[a] Osprey, Vol. I (new series), No. 4, p. 64, April, 1902.

a rod wide by several long the ground was found to be splashed with the chalk-like droppings of the birds, and in spots a foot or more in diameter had been probed to such an extent by their long bills that it reminded one of a colander. The holes thus made were from 1 to 2 inches in depth. An examination of the earth showed that there was a compacted layer of black decaying leaves from one-fourth of an inch to 1 inch in depth. Below the layer of leaves, some of which were not so rotted but that they retained their integrity, was found moist, yellowish-gray sand. Twenty examinations of the ground were made, each within a few inches of a spot marked by the borings, in order to secure specimens of invertebrates on which the woodcock subsists. The ground was dug up to the depth of several inches, and in the region where the leaves and sand met, large numbers of earthworms, spiders, snails, hydrophilid beetles, ground-beetles and their larvæ, and the larvæ of tipulid flies were unearthed. All of these have been taken from the stomachs of woodcock collected elsewhere. A search was made out in the middle of the swamp, where the black humus is from 6 inches to 3 feet in depth, but no food of any consequence could be found, which may account for the absence of woodcock in the middle of the swamp.

On the creeks below Marshall Hall woodcock are abundant, and during the fall of 1901 were slaughtered in enormous numbers. Laws limiting the bag per day and prohibiting summer shooting are greatly needed in this county.

A Wilson snipe (*Gallinago delicata*) was flushed from the swamp on the upper part of the Hungerford farm April 14, 1899.

Two yellowlegs (*Totanus flavipes*) were noted on October 5, 1901, flying along the shore near the calamus swamp.

Solitary sandpipers (*Helodromas solitarius*) and spotted sandpipers (*Actitis macularia*) were observed most often in May. One of the latter birds, which was killed May 16, 1900, had eaten one large black ant, two ground-beetle larvæ, and a dozen May-flies.

Two killdeers (*Ægialitis vocifera*) were seen on the farm April 11, 1899, and one July 24, 1902.

The turnstone (*Arenaria morinella*) has been noted by Mr. O. N. Bryan.

GALLINACEOUS BIRDS.

On the Bryan farm a covey of bobwhites (*Colinus virginianus*, Pl. XV, fig. 1) was found during the fall and winter of 1901 along Persimmon and Partridge branches. They fed in the wheat stubble on the west side of lot 3 (Pl. XII, fig. 2) and slept in the thick broom-sedge of the west side of lot 2 (Pl. XVI, fig. 1). Another covey, which usually inhabited lot 5, could occasionally be seen feeding on the luxuriant growth of partridge pea in lot 4 (Pl. XVI, fig. 2). More of these

birds than usual escaped from gunners, and the following spring (1902) bred about the farm. One pair was located on the edge of the calamus swamp, one on the river bluff near the cabin, one in the middle of lot 4, two on the edge of the woods of lot 5, two along the western boundary fence of the farm, and several along Persimmon and Partridge branches. They were still incubating during the last week of June. The cocks, mounted on fence posts or the lower branches of trees, were whistling their 'Bob White' incessantly. When a cock approached its mate while it was on its nest, it uttered the soft rally note so familiar to the sportsman in the fall. This was followed by a caterwauling much more unbirdlike than that of the yellow-breasted chat. One of its noises resembled that made by a cat calling a kitten. Another suggested the scolding of a caged gray squirrel. Others sounded like a combination of the alarm notes of a hen grouse with chicks and the strident cries of a guinea hen. It also uttered a loud, rasping noise such as might have been emitted by a whip-poor-will with a cracked voice.

In their feeding these birds picked dewberries, gathered scattered grain in wheat stubble, and caught grasshoppers, ground-beetles (*Harpalus pennsylvanicus*), and potato beetles.

The nest of the pair located in lot 4 was discovered on July 10 in the center of the lot amid some thick timothy. It contained eggs which were subsequently destroyed by crows. Young bobwhites are usually hatched before this time at Marshall Hall, according to the reports of farmers, generally during the last week of June; but although a thorough search for young was made up to the 12th of July none were found. Observations were suspended until the 24th, when three broods were found; the first but a day or two out of the shell, the others several days older, but still unable to fly. The older broods were pointed by a dog, and the mother birds flew up and fell flopping a few yards distant, feigning broken wings, while their striped chicks peeped squeakingly and ran with surprising swiftness for cover. In order to ascertain the food habits of these young without killing them, I collected some of their droppings and subsequently examined them. The remains of the food thus found proved to be entirely animal matter, and consisted of ants, true bugs, grasshoppers, ground-beetles, weevils, leaf-eating beetles, other beetles, spiders, and thousand-legs.

Thirteen bobwhites were shot in the middle of November, 1899, 1900, and 1901. Vegetable matter formed 78 percent of their food, and of this all but 8 percent, composed of white-oak acorns, wild fruit, and fruit seeds, was weed seeds. Animal matter amounted to 19 percent, and consisted of 1 spider, 1 true bug (*Alydus eurinus*), 1 parasitic wasp (*Tiphia inornata*), 1 sphinx caterpillar (*Deilephila galii*), 1 cutworm, 1 small ground-beetle, and a larva of another species, 1

12-spotted cucumber-beetle (*Diabrotica 12-punctata*), 1 potato-beetle (*Doryphora 10-lineata*), 7 leaf-hoppers (*Proconia*), and 14 grasshoppers (2 *Xiphidium* and 12 *Melanoplus*).

The freedom with which the bobwhite, regardless of cover, roams about large fields—pastures, meadows, or wheat, tobacco, corn, or truck lands—is very striking. The rapidity with which it moves from point to point, whether by flying or running, makes it less dependent on cover than most of the birds of the farm, and causes it to feed over far more territory than they. As an enemy of insect pests and a destroyer of weed seed it has few equals on the farm. It is the custom at Marshall Hall to shoot these birds for market, where they bring 15 cents apiece, a price that scarcely compensates for the loss of their services.

The ruffed grouse (*Bonasa umbellus*), though rather rare, was found breeding here, and in one instance a bird of the species was seen flying over the Bryan house.

The wild turkey (*Meleagris gallopavo fera*) occurs as a straggler at intervals of several years. A fine gobbler was seen at 4.30 a. m. May 16, 1900, in lot 4, but it quickly disappeared amid the wheat. The next morning it was seen in lot 2; but on discovery it rose and flew to the woods behind the calamus swamp.

PIGEONS AND DOVES.

A specimen of the passenger pigeon (*Ectopistes migratorius*) collected at Marshall Hall by Mr. O. N. Bryan was donated by him to the Smithsonian Institution in 1892.

The mourning dove (*Zenaidura macroura*) has already been shown to be preeminently a seed eater. It consumes great quantities of weed seed and is a useful species on the farm. Three stomachs were collected.

VULTURES.

The turkey buzzard (*Cathartes aura*) is a useful scavenger. Its work on the Bryan farm at Marshall Hall has been described (see p. 53).

HAWKS.

The following hawks were noted:

Marsh hawk (*Circus hudsonius*), 1.
Sharpshinned hawk (*Accipiter velox*).
Cooper hawk (*Accipiter cooperi*).
Red-tailed hawk (*Buteo borealis*).
Red-shouldered hawk (*Buteo lineatus*), 1.
Broad-winged hawk (*Buteo platypterus*), 1.
Golden eagle (*Aquila chrysaëtos*).[a]
Bald eagle (*Haliæetus leucocephalus*).
Sparrow hawk (*Falco sparverius*).
Osprey (*Pandion haliaëtus carolinensis*).

The species which are injurious to poultry, game, and fish and those which are useful in destroying noxious rodents have already been dis-

[a] Recorded on authority of Robert L. Ferguson, of Washington, D. C.

cussed (see pp. 50–55). A stomach of each of the following hawks was examined: Marsh hawk, red-shouldered hawk, and broad-winged hawk. The first contained a meadow mouse; the second, part of a crayfish and 2 frogs; and the third, 2 beetles—a May-beetle (*Lachnosterna*) and a tumblebug (*Geotrupes splendidus*)—part of a meadow mouse, and the remains of 4 short-tailed shrews and a snake (*Storeria*).

A young broad-winged hawk, old enough to fly, which was kept for several weeks, exhibited interesting feeding habits. When a live mouse was placed in the cage, the hawk pounced on it with both feet, sinking its talons into the mouse's vitals, but not once using its beak until after the death struggle. As soon as the mouse had been struck the hawk uttered continual high-keyed shrieks, spread its wings and tail, and pressed them against the ground so as to make an inclosure or tent, the opening of which it guarded with its beak. No such spreading of the wings and tail took place when the prey consisted of big moths, grasshoppers, or beetles. When a three-quarters-grown English sparrow was placed in the cage the hawk struck it a blow with one foot, clutching and killing it instantly. Still gripping the sparrow, it pulled the head off with its beak and swallowed it. Next it ripped open the body cavity and ate the whole digestive tract at one mouthful. Then, beginning with one leg, it finished the sparrow in four more mouthfuls.

The sparrow hawk is the most useful destroyer of insect pests (grasshoppers), while the marsh hawk is the most valuable enemy of injurious rodents. During the fall the latter may be seen skimming over the fields, pouncing upon meadow mice and remaining for some time in the grass eating its prey. This habit has made it an easy mark for the farmers at Marshall Hall, who, on seeing it drop into the grass to feed, have been accustomed to run, often several hundred yards, and shoot it as it rises.

OWLS.

Three short-eared owls (*Asio accipitrinus*) which were killed during November, 1899, 1901, and 1902, contained nothing but meadow mice.

The barred owl (*Syrnium varium*) occurs at Marshall Hall, but is not common.

On May 30, 1892, Mr. E. A. Preble, of the Biological Survey, collected 3 young and 2 adult screech owls (*Megascops asio*) and a great horned owl (*Bubo virginianus*) near the mouth of the calamus swamp on the Bryan farm. Screech owls are of much economic value, owing to the fact that they feed largely on insects and do not destroy birds or poultry. The stomachs of those taken by Mr. Preble contained May-beetles and lizards. In the stomach of the great horned owl were the remains of several dung-beetles, insects of neutral effect on agriculture. As a rule, this bird takes few insects of any kind and is very injurious to poultry.

CUCKOOS.

One black-billed cuckoo (*Coccyzus erythrophthalmus*) and 2 yellow-billed cuckoos (*Coccyzus americanus*, fig. 30) were collected on the Bryan farm in the latter half of May. They had eaten 1 spider, 1 click-beetle, 1 sap-beetle (*Euphoria inda*), 2 rose-chafers (*Macrodactylus subspinosus*), 10 locust leaf-mining beetles (*Odontota dorsalis*), 20 beetles of the firefly family, 1 skipper butterfly (*Eudamus*), 20 caterpillars, of which 18 were the repulsive, large, spiny, black larvæ of the mourning-cloak butterfly (*Vanessa antiopa*), 4 bugs, of which 1 was a green soldier bug (*Nezara hilaris*), and another *Metapodius femoratus*, 10 May-flies, and 20 black insects related to the dobson and known as *Sialis infumata*. Rose-chafers, which are very destructive insects, are eaten by only a few birds. The skipper and cabbage butterflies were the only butterflies eaten by Marshall Hall birds. The larvæ of

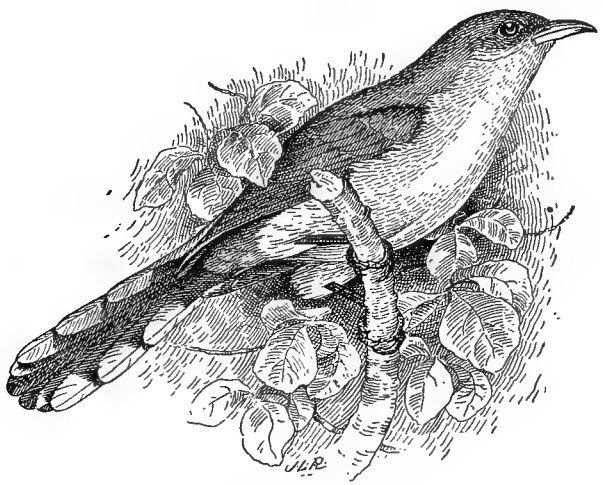


FIG. 30.—Yellow-billed cuckoo.

the mourning-cloak butterfly are often selected by cuckoos, as are also other hairy and spiny caterpillars that other birds avoid. Caterpillars, largely in such forms, make half of the cuckoo's food, grasshoppers and their allies about a third, and beetles, with small numbers of miscellaneous insects, the remaining sixth. The cuckoo is not abundant on the farm. It is undoubtedly the most useful of the exclusively insectivorous birds found at Marshall Hall, because of the protection it gives to the foliage of forest and orchard.

KINGFISHERS.

One pair of kingfishers was seen continually along the shore of lots 1 and 2 (Pl. III, fig. 2), and another pair nested in the sandy bluff of the Hungerford farm. The food of the bird has already

been mentioned in connection with the piscivorous habits of birds (see p. 53). The stomachs of 5 nestlings were examined.

WOODPECKERS.

The following woodpeckers were noted at Marshall Hall:

Downy woodpecker (*Dryobates pubescens*), 13.
Yellow-bellied sapsucker (*Sphyrapicus varius*), 2.
Pileated woodpecker (*Ceophlœus pileatus*).
Red-headed woodpecker (*Melanerpes erythrocephalus*), 1.
Red-bellied woodpecker (*Melanerpes carolinus*).
Flicker (*Colaptes auratus*), 2.

The stomachs of 13 downy woodpeckers were collected. All contained insects and 2 fruit—the berries of smilax and poison ivy. Ants appeared to be the favorite food, having been eaten by all the birds except one. Beetles and their larvæ had been eaten by 8 birds. The kinds selected were click-beetles, ground-beetles (*Amara*), darkling-beetles (*Helops æreus*), and longicorn-beetles (*Elaphidion*). Caterpillars, including *Catocala*, were found in 3 stomachs; miscellaneous insects, principally fly-like insects, in 4; snails in 2, and spiders in 7. Vegetable food amounted to one-fourth of the whole, a proportion probably diminished by the fact that 4 of the stomachs were those of young birds. As the downy woodpecker feeds largely on wood-boring insects and other species that infest tree trunks, it is useful in woodland and orchard.

The yellow-bellied sapsucker (fig. 31) is the cause of all the maledictions that have been heaped on the woodpecker tribe. It secures a large part of its food by drilling holes in tree trunks to serve as wells for collecting the sap on which it feeds. In examining 81 stomachs of this woodpecker, Professor Beal found that sapwood or alburnum formed 23 percent of their contents, a circumstance that indicates the importance of sap in the economy of this species. Sap itself can not be detected unless the stomach is examined immediately, which is impracticable in the case of stomachs sent to the Department of Agriculture.

Several authors have mentioned the fact that this bird kills birches. The following field notes show the manner in which it works injury to apple trees:

In the summer of 1895 there was on the Bryan farm a little orchard of 9 apple trees, about twelve years old, that appeared perfectly healthy. In the fall sapsuckers tapped them in many places, and during spring and fall of the next four years they resorted to them regularly for supplies of sap. Observations were made (October 15, 1896) of two sapsuckers in adjoining trees of the orchard. From a point 20 feet distant they were watched for three hours with powerful glasses to see whether they fed to any considerable extent on ants and

other insects that were running over the tree trunks. In that time one bird seized an ant and the other snapped at some flying insect. One drank sap from the drills 30 and the other 41 times. Later in the day one drilled 2 new holes and the other 5. The holes were made in more or less regular rings about the trunk, one ring close above another, for a distance of 6 to 8 inches. The drills were about a quarter of an inch deep, and penetrated the bark and the outer part of the wood.

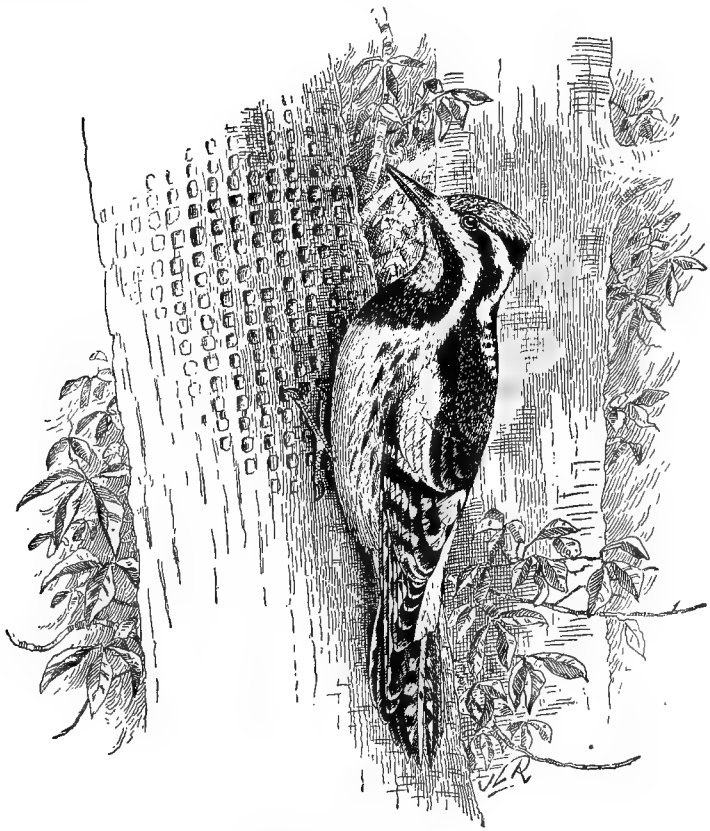


FIG. 31.—Yellow-bellied sapsucker.

In November, 1900, 7 of the 9 trees were dead and the others were dying. A strip of bark 7 inches long by 2 wide, where the sapsuckers had worked in 1896, was torn off and found to contain 84 drills, an average of 6 to the square inch. Many of them were so close together that the tissue between had broken down, leaving rents in the bark an inch or two long, and in some places almost girdling the tree. The loss of sap must have been an exhausting drain, but it was not the sole cause of death. Beetles of the flat-headed apple borer, attracted by the

exuding sap, had oviposited in the holes, and the next generation, having thus gained an entrance, had finished the deadly work begun by the sapsuckers. Holes made by birds are sometimes closed by burl-like knobs of wood, but if they remain open the death of the tree from borers is very likely to result. In the case of the trees killed at Marshall Hall, galleries made by borers had honeycombed the wood beneath the section of bark riddled by the sapsuckers.

Only 2 stomachs of sapsuckers were collected. They were taken during the middle of November, 1899 and 1900, and contained several dung-beetles (*Aphodius*) and the fruit of woodbine and red cedar.

The red-headed woodpecker is not common at Marshall Hall, though it was seen in small numbers every fall. One specimen taken Novem-

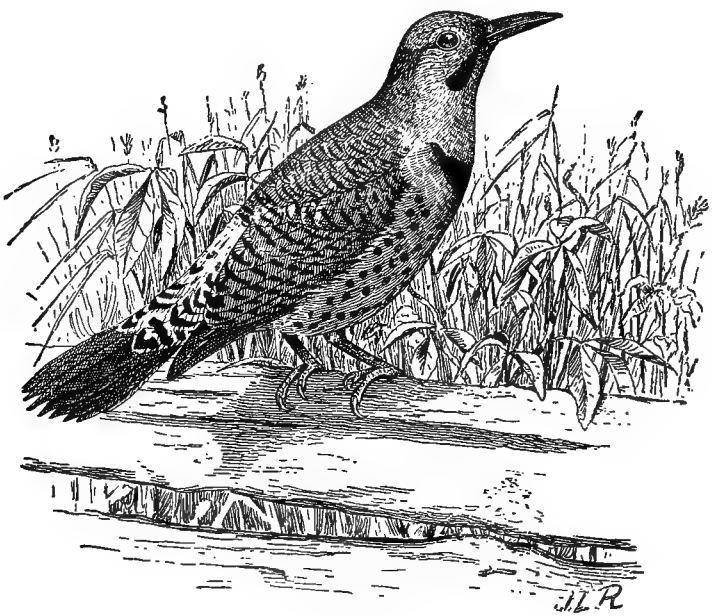


FIG. 32.—Flicker.

ber 29, 1900, among the swamp oaks south of lots 4 and 5, had eaten gall insects (Cynipidæ) and many bits of the woody tissue of the gall. This woodpecker makes about half its food on vegetable matter, largely mast with some berries, and selects for its insect food chiefly beetles, ants, and grasshoppers. It is, on the whole, useful.

The flicker (fig. 32), though nesting on the farm, was common only during migration, when it was seen in flocks of from 6 to 12. A stomach collected in the middle of November, 1899, contained 10 ground-beetles (including *Anisodactylus*, *Harpalus pennsylvanicus*, and *Pterostichus sayi*), 5 ants, 1 sow bug, 1 black cricket and skin, and 20 seeds of woodbine berries. The flicker is somewhat more insectiv-

orous than the redhead. Its vegetable food usually consists of a little mast and a good deal of wild fruit. It is less of a woodpecker than any other species of the family, for it is much less arboreal and spends a large part of the time on the ground securing ants with its long sticky tongue. As many as 5,000 ants have been taken from one stomach. So important is this article of diet that it forms three-fourths of the insect food of the species.

WHIP-POOR-WILLS, NIGHT-HAWKS, SWIFTS, AND HUMMING-BIRDS.

Whip-poor-wills (*Antrostomus vociferus*) and night-hawks (*Chordeiles virginianus*), two exclusively insectivorous species, are highly useful. The former was frequently heard, and the latter was frequently seen in late summer as it soared over the farm after ants.

The chimney swift (*Chætura pelagica*) is, as might be expected, wholly insectivorous. Three birds collected July 18, 1898, had caught the following insects on the wing: One small bee (Andrenidæ), 3 bugs (Heteroptera), and 34 weevils (*Sitones hispidulus*).

The ruby-throated hummingbird (*Trochilus colubris*) feeds on insects and the nectar of flowers. During the last of May it visited the flowers of the persimmon, in June the honeysuckle, and later tobacco and the trumpet creeper. A bird that was shot fresh from a trumpet flower had eaten 1 little green bee (Andrenidæ) and 1 minute spider.

FLYCATCHERS.

The following species of flycatchers have been noted at Marshall Hall:

Scissor-tailed Flycatcher (*Muscivora forficata*). Noted by Mr. O. N. Bryan.
Kingbird (*Tyrannus tyrannus*), 16.
Great crested flycatcher (*Myiarchus crinitus*), 4.
Phœbe (*Sayornis phœbe*), 3.
Wood pewee (*Contopus virens*), 11.
Acadian flycatcher (*Empidonax virescens*), 1.

Sixteen kingbirds were collected from May 28 to July 30. Insects formed 71 percent and fruit 29 percent of their food. The fruit consisted of cherries, sassafras, wild and cultivated mulberries, elder, and blackberries. The proportion of insect food was not so large as is typical for the species, a circumstance resulting probably from the readiness with which fruit could be obtained. Beetles constituted 37 percent of the food, grasshoppers and crickets 23 percent, ants and bees 4 percent, parasitic wasps 2 percent, miscellaneous insects, including caterpillars and bugs, 3 percent, and spiders 2 percent. Among the miscellaneous insects were a stink bug (*Hymenarcys nervosa*), an assassin bug (*Sinea diadema*), and a whole cabbage butterfly (*Pieris rapæ*). The bees included small wild species (Andrenidæ) and drones

of honey bees. The parasitic wasps included forms of the families Ichneumonidæ and Scoliidæ. Of the beetles, which were by all means the most interesting element of the insect food, ground-beetles (including *Anisodactylus* and *Cratacanthus dubius*) furnished 2 percent, tiger-beetles, soldier-beetles (*Chauliognathus pennsylvanicus*), and dung-beetles (*Atænius* and *Aphodius*) 3 percent, and injurious beetles of the following species 30 percent:

Rose-chafer (*Macrodactylus subspinosus*).
Southern June-beetle (*Allorhina nitida*).
Shining leaf-chafer (*Anomala*).
Sad flower-beetle (*Euphoria melancholica*).
Long-horned beetles (including *Leptura*).
Locust leaf-mining beetle (*Odontota dorsalis*).
Blister-beetle (*Epicauta cinerea*).
Asparagus-beetle (*Crioceris asparagi*).

Asparagus-beetles and blister-beetles are scarcely ever eaten by other birds and rose-chafers seldom; hence the service rendered by the kingbird in destroying these insects and others of an injurious character in large numbers makes it one of the most valuable allies of the farmer.

Of the remaining flycatchers collected, the wood pewee and the Acadian flycatcher are purely insectivorous, and the phœbe and the great crested flycatcher, though subsisting chiefly on insects, quite often, especially in late summer, vary their fare with fruit.

One Acadian flycatcher was collected. It had eaten a spider, a parasitic wasp, a long-horned beetle, a leaf-beetle (*Crepidodera*), and a banded-winged horsefly (*Chrysops*).

Of 11 wood pewees all had taken beetles, including click-beetles, long-horned beetles (*Leptura rubrica*), dung-beetles (*Onthophagus pennsylvanicus*), soldier-beetles (*Chauliognathus pennsylvanicus*), locust leaf-mining beetles (*Odontota dorsalis*) and a related leaf-beetle (*Hæmonia nigricornis*), and weevils of the species *Phytonomus punctatus* and *Sphenophorus zeæ*. Seven had destroyed parasitic wasps, including Braconidæ, Evaniidæ, Ichneumonidæ (*Mesostenus* and others), and Scoliidæ (*Tiphia inornata*); 4 had eaten flies (*Chironomus*, *Sapromyza vulgaris*, *Lucilia cæsar*, and other muscid flies); 1 had taken a moth; and 3 had eaten, respectively, a caddis-fly, a May-beetle, and a spider. Although the wood pewee destroys large numbers of injurious insects, especially beetles, it feeds so eagerly on the useful parasitic wasps that its scarcity at Marshall Hall was perhaps fortunate for the owners of the farms.

Three phœbe (fig. 33) stomachs were collected. Their contents were chiefly beetles of the following kinds:

Anisodactylus.
Cicindela.
Chauliognathus pennsylvanicus.
Canthon.
Aphodius inquinatus.
Onthophagus pennsylvanicus.
Lachnosterna.
Odontota dorsalis.
Orsodachna atra.
Collops quadrimaculatus.
Lema trilineata.

In smaller numbers the birds had eaten flying ants, parasitic wasps, and other wasps, bugs, caddis-flies, and spiders. One had tasted blackberries.

Four great crested flycatchers were collected in May. Their stomachs contained May-flies, ants (*Camponotus pennsylvanicus* and other forms), parasitic wasps (Ichneumonidæ, Scoliidæ (*Tiphia*) and Evaniidæ), bugs (*Euschistus* and *Nezara hilaris*), and beetles (Curculionidæ, Elateridæ, *Cicindela sexguttata*, *Dicerca*, and *Odontota dorsalis*). Despite their

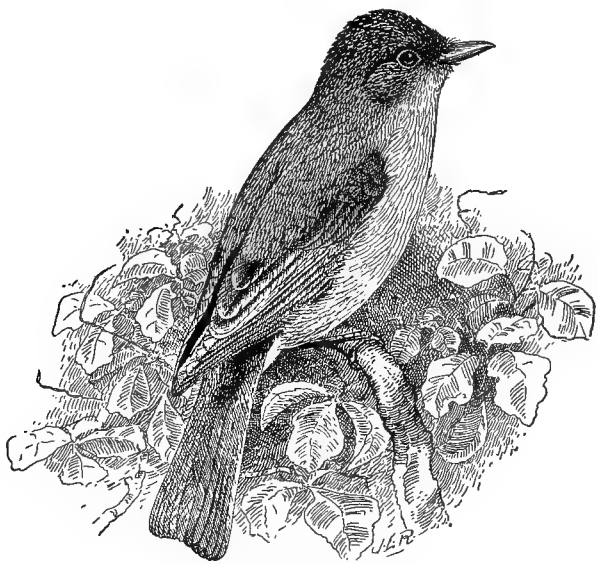


FIG. 33.—Phœbe.

taste for parasitic wasps both phœbe and great crested flycatcher are in the main useful on account of the large number of insect pests they destroy.

HORNED LARKS.

When the horned lark (*Otocoris alpestris*) occurred at Marshall Hall, as it did occasionally in severe winter weather, it subsisted almost entirely on seeds, largely weed seeds, often with waste grain. A bird collected during the severe blizzard of February, 1900, was feeding in a wind-swept cowyard, where it secured a bit of a kernel of corn, 4 seeds of lamb's-quarters, 8 of crab-grass, 10 of bastard pennyroyal, and 12 of ragweed.

BLUE JAYS AND CROWS.

Six blue jays (*Cyanocitta cristata*, fig. 34) were collected in May and November. All except one had taken insects. Beetles were the most important element and comprised *Chlænius æstivus*, *Lachnosterna*,

Euphoria fulgida, *Onthophagus*, Elateridæ, and Curculionidæ. The less important element was composed of parasitic wasps, May-flies, and grasshoppers (Locustidæ). One bird had eaten a snail and one a spider. One had taken mulberries and all had eaten acorns. Mast formed half the total volume of food. None of these six specimens had eaten grain, which usually enters into the blue jay's food to some extent, and in certain localities in New Hampshire that came under direct observation furnished a significant part of it. The blue jay takes about three times as much vegetable as animal food. It appears to do no harm at Marshall Hall and consumes a fair quantity of injurious beetles, grasshoppers, and caterpillars.

The common crow (*Corvus americanus*) was much more numerous on the farm than the fish crow (*Corvus ossifragus*). Four stomachs of the former species were collected. In the case of this bird, which, as has been shown, attacks poultry and grain (see pp. 50 and 65), protection

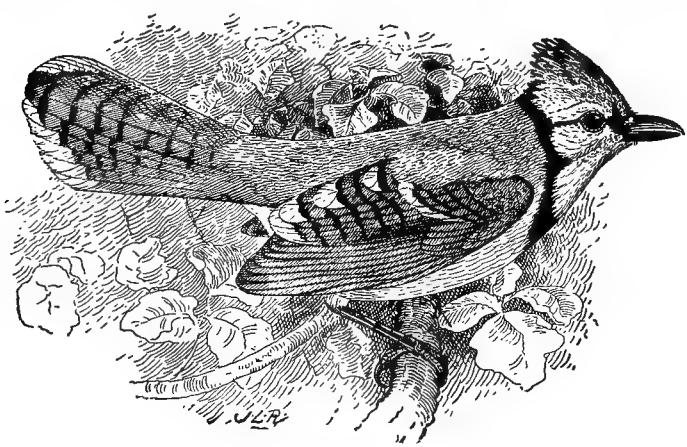


FIG. 34.—Blue jay.

is not desirable at Marshall Hall. Elsewhere the species may do as much good as harm, perhaps even more, but here local conditions make encouragement of its presence incompatible with prudent farming.

MEADOWLARKS, BOBOLINKS, AND COWBIRDS.

The meadowlark (*Sturnella magna*) is one of the class of highly useful birds. It is commonly supposed to be largely vegetarian, but it really takes about three times as much animal matter as vegetable. One-third of this major part is usually composed of grasshoppers, though these insects were not abundant enough at Marshall Hall to enter largely into the food of the 7 meadowlarks collected. Injurious beetles and caterpillars, however, were taken in customary quantities. The meadowlark, which is commonly regarded as a game bird at

Marshall Hall, is frequently shot, and its valuable work as a destroyer of weed seed and insects is thus often cut off.

When the bobolink (*Dolichonyx oryzivorus*, fig. 35) tarries on the farm in its southward migration it lives wholly on the wild rice of the calamus swamp, but on its return journey in May it eats injurious insects and weed seed of the wheat and clover fields. Six stomachs were collected in May.

The cowbird (*Molothrus ater*), as has been shown by Prof. F. E. L. Beal,[a] takes three times the volume of seeds that it takes of insects. Both of the 2 stomachs examined contained grasshoppers (*Xiphidium* and *Melanoplus*) and 1 of them leaf-hoppers, two elements character-

FIG. 35.—Bobolink.

istic of the insect food of the species. The bird does little damage to grain fields, and renders much service with other birds in reducing the weed-seed harvest of the farm.

BLACKBIRDS AND ORIOLES.

The red-winged blackbird (*Agelaius phœniceus*, fig. 36), however destructive to grain it may be elsewhere, does no damage in the grain-fields at Marshall Hall. Its insect food, which is to its vegetable food as one to three, is composed largely of weevils, caterpillars, and grass-

[a] Bobolink, Blackbirds, and Grackles. Bull. No. 13, Biological Survey, Dept. of Agriculture, p. 29, 1900.

hoppers. Its good work among weeds has been previously described (see p. 77). Eight stomachs were examined, but with little significance of result, for the temporary abundance of May-flies had diverted the birds from insect pests.

One stomach of the rusty blackbird (*Scolecophagus carolinus*) was collected April 14, 1899. It contained beetles (*Harpalus* and *Sitones*), 1 caterpillar, 1 small bee, and some waste corn. The character and extent of weed-seed destruction by rusty blackbirds on the farms at Marshall Hall has been shown on p. 77.

Crow blackbirds (*Quiscalus quiscula*) have been proved by examination of thousands of stomachs to take fully twice as much vegetable as animal food, the vegetable food being chiefly grain and fruit. And at Marshall Hall, after the young were established in life and the hosts of Northern birds, including the subspecies *Quiscalus quiscala æneus*, had arrived, systematic pillage of grain fields took place (see p. 67), which could be checked only by the shotgun. Twenty-five stomachs of the species were examined.

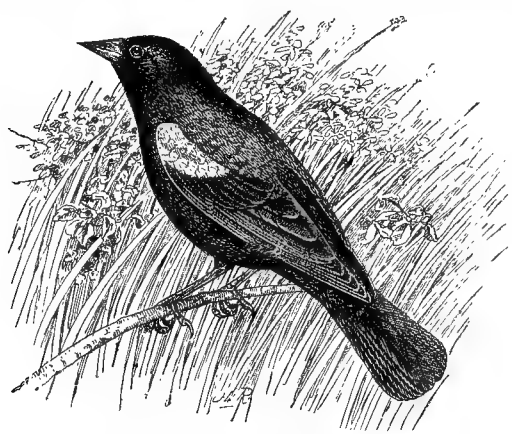


FIG. 36.—Red-winged blackbird.

The orchard oriole (*Icterus spurius*) is a summer resident at Marshall Hall and may usually be found nesting during the breeding season to the extent of a dozen pairs, though the present summer (1902) formed an exception to this rule, the usual number being reduced to 2 or 3. The food of this species, as shown in 11 stomachs collected during May and June, was composed of 91 percent animal matter and 9 percent vegetable matter. The latter part was nearly all mulberries; the former was distributed as follows: Fly larvæ, 1 percent; parasitic wasps, 2 percent; ants, 4 percent; bugs, 5 percent; caterpillars, 12 percent; grasshoppers, including a few crickets, 13 percent; beetles, 14 percent; May-flies, 27 percent; spiders, 13 percent. Thus beneficial insects—parasitic wasps—formed only 2 percent of the food, and injurious species—caterpillars, grasshoppers, and harmful beetles—amounted to 38 percent.

The Baltimore oriole (*Icterus galbula*) is also a highly insectivorous, useful species, but occurs at Marshall Hall only during migration. One bird was collected May 29, 1896. It had eaten mulberries, 2 small wasps, 2 fall webworms, 1 click-beetle, and 15 locust leaf-mining beetles.

FIG. 1.—BLUEBIRD AT EDGE OF NEST WITH GRASSHOPPER IN MOUTH.

From photograph by Rev. P. B. Peabody.

FIG. 2.—FORMER NESTING SITE OF BLUEBIRDS ON LAWN AT BRYAN FARM.

The hole used by the birds may be seen about halfway to the top of the tree against which the gun is leaning. As in Plate I Mount Vernon is to be seen in the distance.

FINCHES AND SPARROWS.

One purple finch (*Carpodacus purpureus*) was collected (February 20, 1900) from a flock feeding on cedar berries. Examination revealed, therefore, only remains of this fruit.

Specimens of the red crossbill (*Loxia curvirostra minor*) and the white-winged crossbill (*Loxia leucoptera*) were collected at Marshall Hall by Mr. O. N. Bryan, who presented them to the U. S. National Museum.

Eleven goldfinches (*Astragalinus tristis*) were collected. Insects (caterpillars) had been eaten by only one, practically all the food consisting of seeds, principally weed seeds. The goldfinch is probably the most useful seed-eater on the farm.

Several pine siskins (*Spinus pinus*) were seen December 1, 1901, in company with goldfinches.

The following native sparrows were noted:

Vesper sparrow (*Pœcetes gramineus*).
Savanna sparrow (*Ammodramus sandwichensis savanna*), 1.
Grasshopper sparrow (*Ammodramus savannarum passerinus*), 10.
Henslow sparrow (*Ammodramus henslowi*), 1.
White-throated sparrow (*Zonotrichia albicollis*), 17.
Tree sparrow (*Spizella monticola*), 9.
Chipping sparrow (*Spizella socialis*), 61.
Field sparrow (*Spizella pusilla*), 31.
unco (*Junco hyemalis*), 11.
Song sparrow (*Melospiza melodia*), 36.
Lincoln sparrow (*Melospiza lincolni*).
Fox sparrow (*Passerella iliaca*).

From May to September, inclusive, half the food of field, song, chipping, and grasshopper sparrows consists of insects. The grasshopper sparrow is the most insectivorous of the four, but a description of the insect food taken by it at Marshall Hall will serve, because of similarity, to indicate that of the other three. The main part was composed of beetles, caterpillars, and grasshoppers. The beetles included *Sitones hispidulus*, *Drasterius*, *Systena elongata*, *Systena blanda*, *Colaspis brunnea*, *Anisodactylus*, and *Atænius*. The caterpillars belonged chiefly to the family Noctuidæ, including many cutworms and army worms. Caterpillars of the family Geometridæ were occasionally eaten. The grasshoppers were of the genera *Xiphidium*, *Scudderia*, *Melanoplus*, *Hippiscus*, and *Dissosteira*. The following bugs also had been eaten: *Corizus*, *Trichopepla semivittata*, *Hymenarcys nervosa*, and *Alydus pilosulus*. Spiders were frequently taken.

The chipping and field sparrows sometimes destroy small numbers of useful parasitic wasps, and the song sparrow now and then eats the less beneficial smaller ground-beetles. The insectivorous habits of all

these native species are, on the whole, however, extremely valuable to man. The consumption of weed seeds, the chief service of these birds as well as of those that visit the farm only in the colder season, has already been emphasized (see p. 72). For a detailed account of the food habits of sparrows the reader is referred to 'The Relation of Sparrows to Agriculture.'[a] As there shown, and as set forth in the first part of this bulletin (see p. 17), the English sparrow differs radically in habits from the native sparrows and is a pest that should be exterminated.

One towhee (*Pipilo erythrophthalmus*) was taken September 9, 1896. Its stomach was found to contain a locust leaf-mining beetle, a weevil, a ground-beetle, a bug, a cricket, 6 ants, and remains of broken seeds.

Ten cardinals (*Cardinalis cardinalis*) were collected from February to November, inclusive, with the omission of March. Twenty-two percent of their food consisted of animal matter (insects and spiders) and 78 percent of vegetable matter (half fruit and half seeds). Of the minor proportion, bugs formed 1 percent; spiders, May-flies, and grasshoppers, each 2 percent, and beetles 15 percent. The beetles were as follows: *Agrilus egenus*, *Dicerca obscura*, *Macrodactylus subspinosus*, *Donacia*, *Odontota dorsalis*, *Hyperplatys aspersus*, *Anisodactylus agricola*. On November 29, 1901, two cardinals were noted eating seeds of the tulip tree.

One stomach of the indigo bird (*Cyanospiza cyanea*) was examined. It held 1 beetle (*Agrilus egenus*) and a little vegetable débris.

TANAGERS.

At Marshall Hall tanagers were never detected pilfering cultivated fruit, as they have often been known to do elsewhere.

One summer tanager (*Piranga rubra*), collected August 5, 1898, had eaten wild blackberries, a bee (*Agapostemon*), and a scoliid wasp.

Three scarlet tanagers (*Piranga erythromelas*), taken in May and August, had fed exclusively on insects, which comprised a bee (*Halictus*), parasitic wasps, white ants, a soldier bug (*Nezara hilaris*), click-beetles, darkling-beetles (*Helops micans*), and the sad flower-beetle (*Euphoria melancholica*).

SWALLOWS.

The following swallows were noted:

Purple martin (*Progne subis*), 2.
Barn swallow (*Hirundo erythrogastra*), 10.
White-bellied swallow (*Tachycineta bicolor*), 5.
Bank swallow (*Riparia riparia*), 6.
Rough-winged swallow (*Stelgidopteryx serripennis*), 7.

[a] The Relation of Sparrows to Agriculture. Bull. No. 15, Biological Survey, Dept. of Agriculture, Washington, 1901.

Thirty swallows, collected between the middle of May and the middle of August, had eaten nothing but insects. Parasitic wasps and bees formed 2 percent of their food (less than usual with aerial feeders), bugs 3 percent, May-flies 8 percent, beetles 13 percent, white ants 21 percent, ants 33 percent, and miscellaneous insects, principally flies with a few bugs, 20 percent. The forms selected were bees of the family Andrenidæ, and parasitic wasps of the families Scoliidæ, Ichneumonidæ, and Chalcididæ. The beetle food was interesting, for besides click-beetles, dung-beetles (*Aphodius inquinatus*, *Hister*, *Atænius*, and *Onthophagus pennsylvanicus*), weevils of several species, and metallic woodborers (*Agrilus*), it included the engraver beetles (among them *Tomicus cacographus*), which are destroyed by only few other birds. The food of swallows is peculiar in its lack of caterpillars and grasshoppers, which are so important to the subsistence of other birds. As with flycatchers, the number of flies taken is generally overestimated. In the stomachs examined were found snipe-flies (Leptidæ), golden-green flesh-flies (*Lucilia cæsar*), and other muscidæ, with an occasional banded-winged horse-fly (*Chrysops*).

CEDAR BIRDS.

The cedar bird (*Ampelis cedrorum*, fig. 37) is the most frugivorous of the Marshall Hall birds. More than four-fifths of its food was

FIG. 37.—Cedar bird.

fruit, the remainder insects. Though often troublesome elsewhere, it does no harm here, and accomplishes some good through its slightly insectivorous habit. Five stomachs were collected in May. One contained cherries, one mulberries, and a third smilax berries. Insects (locust leaf-mining beetles and May-flies) were found in three.

SHRIKES.

The impaling of grasshoppers and mice by the loggerhead shrike (*Lanius ludovicianus*) near the storage barn has already been mentioned (see p. 54). The only other field observation was on October 23, 1901, when a shrike near the same place was seen to kill a garter snake (*Eutainia*) 13 inches long. Owing to the small number of shrikes at Marshall Hall no specimens were taken, but in order to investigate the feeding habits some experiments were carried on with a captive bird given me by Mr. William Palmer. The habit the bird has of impaling prey has been the subject of considerable speculation, some writers maintaining that it gibbets its victims alive for the pleasure of watching their death struggles, and others that it slaughters more game at a time than it can eat and hangs up the surplus to provide against a time of want. This theory of prudent foresight may explain why it kills more game than it can eat, but, as the experiments showed, it does not touch the real reason why it impales its prey.

On the day after the shrike in question was captured a dead mouse was offered it. The shrike raised its wings, moved its tail up and down petulantly after the manner of the phœbe, and then seized the mouse and dragged it about for several minutes, trying to wedge it into first one and then another corner of the cage. Failing in this effort, it tried to impale the mouse on the blunt broken end of a branch that had been placed in the cage for a perch, but the body fell to the floor. Then it tried to hold the mouse with its feet and tear it to pieces, but its feet were too weak. A nail was now driven into the cage so as to expose the point. Immediately the shrike impaled its prey, fixing it firmly, and then fell to tearing and eating ravenously. Several days later the nail was removed and a piece of beef was given to the shrike. By dint of hard work it managed to hold the beef with its feet, so that it could bite off pieces; but it much preferred to have me do the holding, when it would perch on my wrist and pull off mouthfuls in rapid succession. These experiments indicate that the shrike is unable to tear to pieces food that is not securely fixed. Hawks can grip their food with their powerful talons and then easily tear it into pieces small enough to be swallowed, but the shrike's feet have not a sufficiently vigorous clutch to permit this method.

A series of experiments in feeding insects to this shrike was also carried out. If the bird was very hungry it did not impale insects. When offered a grasshopper (*Hippiscus*) at such times, it would clutch it with one foot, and, resting the bend of its leg on the perch, bite off mouthfuls and swallow them. When not very hungry it impaled grasshoppers and caterpillars (*Sphinx catalpæ*). Such prey as the thousand-legs, centipedes (*Lithobius*), house-flies, and blow-flies (*Cal-*

liphora vomitoria), and in a single instance, a mourning-cloak butterfly, it ate at a single gulp, but very large insects, such as tumblebugs (*Copris carolina*), it always impaled. It refused larvæ of the mourning-cloak butterfly, the forest tent caterpillar, the fall webworm, and the tussock moth. It would not eat a skin-beetle (*Trox*), but took with relish May-beetles (*Lachnosterna*), flower-beetles (*Trichius piger*), and long-horned beetles (*Monohammus*). Insects provided with especial protective devices were used in some of the experiments. Drone and worker honey bees were eaten, but with no apparent relish. The highly flavored cabbage bug (*Murgantia histrionica*) was rejected, but its near relative (*Euschistus*), a stink bug, was greedily devoured. The investigation of insect food was concluded with tests by means of certain beetles possessing ill-flavored, highly irritating secretions. A burying-beetle (*Silpha inæqualis*), a 12-spotted cucumber-beetle (*Diabrotica 12-punctata*), and a blister-beetle (*Epicauta vittata*), were refused, but an oil-beetle (*Meloe angusticollis*), provided with very powerful irritating secretions, was eaten with relish. The moth of the salt-marsh caterpillar, an insect with a vile odor, was also very palatable. The green ground-beetle (*Calosoma scrutator*), which throws out a nauseous volatile, acid fluid, highly irritating, was tried. When this big insect was placed in the cage, the shrike seized it by the prothorax, bit it vigorously and knocked off its head, and then impaled the body. The beetle's pungent odor filled the room, but the shrike removed the elytra with its bill, and after swallowing the thorax bolted the abdomen at a gulp. In the next experiment a *Calosoma* was so presented to the shrike that the latter had to seize it by the tip of the abdomen. The beetle ejected its irritating ill-smelling secretion full in the bird's face. The shrike staggered an instant, then flew to the farther side of the cage, apparently in distress. It was several days before it dared to accept another *Calosoma*.

A series of experiments with mice, birds, and other vertebrates was also made. When a live mouse was placed in the cage the shrike gave chase, half running, half flying. It soon caught the animal by the loose skin of the back, but quickly let go because the little rodent turned on it savagely. In the next attack it seized the mouse by the back of the neck and bit through the skull into the base of the brain, causing instant death. (A broad-winged hawk experimented with at the same time always killed its victims with its talons, never touching them with its beak until they were dead.) A honey-locust perch, set with sharp thorns 2 inches long, had been put into the shrike's cage, and on this it fixed the mouse, a thorn entering below the shoulder blade and passing out through the breast. Then (10 a. m.) it ate the brains. At 10.30 it picked from twenty to thirty mouthfuls of hair from the hind quarters, made incisions and removed the skin, and then ate the large muscles. By 11.30 it had devoured the whole body,

including viscera and skin. Several days later the shrike dispatched a live English sparrow about as it had the mouse, and impaled the carcass. Then it plucked the breast and ate the pectoral muscles, the lungs, and the heart. Live snakes (*Storeria dekayi*) and lizards (*Sceloporus undulatus*) were also fed to the shrike. A toad was put into the cage, and it attacked it, but soon desisted in evident distress, caused probably by the toad's irritating secretions. Frogs and salamanders (*Plethodon*) it relished. Goldfish and bass 2 or 3 inches long it killed, impaled, and ate.

It disgorged indigestible parts of its food in pellets, after the manner of hawks and owls. Pellets of insects were not compact and fell to pieces readily, but those made of remains of mice or birds were firm and kept their shape. When it was fed on May-beetles it disgorged a pellet in one hour and twenty minutes; when fed on a mouse, in three hours. The latter pellet was 7 by 18 millimeters in size and shaped like an olive seed. The largest one ejected contained the remains of a bird and a snake and measured 33 by 11 millimeters. When vertebrates had been eaten their bones were found inside the pellet and the fur, feathers, or scales outside.

VIREOS.

Twenty-five vireos were collected, including 2 warbling vireos (*Vireo gilvus*), 10 white-eyed vireos (*Vireo noveboracensis*), and 13 red-eyed vireos (*Vireo olivaceus*). Ninety-one percent of their food consisted of insects and 9 percent of fruit (mulberries and sassafras). Parasitic wasps formed 2 percent, ants and other Hymenoptera 6 percent, May-flies 4 percent, caterpillars 15 percent, bugs 17 percent, beetles 28 percent, miscellaneous insects 8 percent, and spiders 11 percent. The Hymenoptera, other than ants, comprised jointworm flies, saw-fly larvæ, ichneumon flies, and bees of the genus *Halictus*. The beetles included the following kinds:

Typophorus canellus.
Diabrotica 12-punctata.
Odontota dorsalis.
Mordella 8-punctata.
Symphora rugosa.
Ecyrus dasycerus.
Leptura zebra.
Hyperplatys aspersus.
Anomala.
Crepidodera.
Colaspis brunnea.
Coptocycla bicolor.
Limonius quercinus.
Agrilus.
Helops venustus.
Helops micans.
Tanymecus confertus and other Rhynchophora.

The bugs were stink bugs (*Podisus*), leaf-hoppers (*Jassidæ*), and scale insects (*Kermes*). The yellow-throated vireo (*Vireo flavifrons*) has been noted at Marshall Hall by Mr. William Palmer. All the vireos are very useful protectors of forest and fruit trees.

WARBLERS.

The list of warblers noted at Marshall Hall is given below:

Black and white warbler (*Mniotilta varia*).
Worm-eating warbler (*Helmitherus vermivorus*), 1.
Northern parula warbler (*Compsothlypis americana usneæ*), 1.
Yellow warbler (*Dendroica æstiva*), 7.
Black-throated blue warbler (*Dendroica cærulescens*).
Myrtle warbler (*Dendroica coronata*), 2.
Magnolia warbler (*Dendroica maculosa*), 2.
Chestnut-sided warbler (*Dendroica pensylvanica*).
Black-poll warbler (*Dendroica striata*), 11.
Yellow-throated warbler (*Dendroica dominica*).
Black-throated green warbler (*Dendroica virens*).
Pine warbler (*Dendroica vigorsi*).
Yellow palm warbler (*Dendroica palmarum hypochrysea*). Noted by Mr. William Palmer.
Prairie warbler (*Dendroica discolor*), 1.
Oven-bird (*Seiurus aurocapillus*), 1.
Water-thrush (*Seiurus noveboracensis*), 2.
Louisiana water-thrush (*Seiurus motacilla*), 1.
Kentucky warbler (*Geothlypis formosa*).
Maryland yellow-throat (*Geothlypis trichas*), 13.
Yellow-breasted chat (*Icteria virens*), 4.
Hooded warbler (*Wilsonia mitrata*). Noted by Mr. William Palmer.
Wilson warbler (*Wilsonia pusilla*), 1.
Canadian warbler (*Wilsonia canadensis*), 1.
Redstart (*Setophaga ruticilla*), 5.

Of the food of the 53 specimens collected 96 percent consisted of insects and 4 percent of fruit. The insect food was distributed as follows: Beetles, 21 percent; ants, wasps, and bees, 18 percent; May-flies, 16 percent; caterpillars, 14 percent; bugs (leaf-hoppers, scale insects, and true bugs) 6 percent; miscellaneous insects, including flies, a few grasshoppers, and others, 8 percent; spiders, 11 percent; and miscellaneous invertebrates, principally snails, 2 percent. Of the 21 percent of beetles 3 percent were useful forms, 5 percent neutral, and 13 percent injurious. The following beetles were identified:

Chlænius (larva).
Harpalus (larva).
Anisodactylus rusticus.
Chauliognathus.
Staphylinidæ.
Ptinidæ.
Ligyrus gibbosus.
Euphoria.
Serica vespertina.
Aphodius.
Atænius.
Limonius quercinus.
Cerambycidæ.
Notoxus bicolor.
Bruchidæ.
Rhynchophora (Otiorhynchidæ, *Apion*, etc.).
Xanthonia villosula.
Systena elongata.
Crepidodera helxines.
Odontota dorsalis.

The Hymenoptera comprised the following: 11 percent of the total food, ants, and small bees (*Andrena* and *Halictus*); 4 percent useful

parasitic wasps (*Tiphia inornata* and Ichneumonidæ), and 3 percent jointworm-flies and larvæ of saw-flies. The bugs were scale insects, leaf-hoppers, and true bugs, including *Lygæidæ*, *Sinea diadema* and *Podisus*. In several instances warblers had fed on the eggs of bugs.

Some differences naturally appeared between the food of the purely arboreal species and that of the more terrestrial. Water-thrushes took ground-beetles. Maryland yellow-throats secured more grasshoppers than were taken by arboreal warblers. The yellow-breasted chat, larger than the other species, ate such large beetles as *Ligyrus* and *Euphoria*. It also fed on larvæ of ground-beetles, which are outside the feeding range of strictly arboreal warblers. In a chat's stomach elderberries were found, and in the stomachs of two myrtle warblers collected in February was the fruit of red cedar. The arboreal warblers other than the myrtle warbler are probably almost purely insectivorous.

Most of the warblers of the genus *Dendroica* destroy immense quantities of insects. As an illustration of their value in this regard an extract is quoted from a letter concerning the palm warbler received by the Biological Survey from Mr. Robert H. Coleman:

> I counted the number of insects he caught in a minute and found it varied from 40 to 60 per minute. He spent at least four hours on our piazza, and in that time must have gathered in about 9,500 insects.

MOCKINGBIRDS, CATBIRDS, THRASHERS, AND WRENS.

The mockingbird (*Mimus polyglottos*, fig. 38) was usually seen at Marshall Hall only in fall and spring, but during 1902 a pair nested near the cow barn. In the middle of November, 1899, two stomachs were collected. One contained the skin and 25 seeds of pokeberries and another 34 of the same seeds, the leg of an ant, and the remains of a larval ground-beetle. The bird's selection of ants and ground-beetles shows affinity in food habits with its nearest relative, the catbird. Both species are highly frugivorous, and where abundant in fruit-growing districts may do some harm.

The catbird (*Galeoscoptes carolinensis*) is the most numerous bird during the breeding season on the Bryan farm at Marshall Hall. The examination of 74 stomachs, collected from May to August, inclusive, showed that 41 percent of the food consisted of animal matter and 59 percent of vegetable matter. The latter part comprised the following fruits: Cultivated cherries, wild black cherries, black raspberries, dewberries, blackberries, strawberries, mulberries, pokeberries, elder berries, blueberries, and the berries of sassafras, woodbine, and catbrier. Of the animal matter, snails and thousand-legs composed 1 percent, spiders 2 percent, parasitic wasps 1 percent, ants 6 percent, caterpillars 6 percent, beetles 10 percent, May-flies 14 percent, and miscellaneous insects 1 percent, including grasshoppers, bees (*Halictus*

and *Andrena*), bugs (*Euschistus*, *Corimelæna*, etc.), and flies (Tipulidæ and *Calliphora vomitoria*, the caddis-flies and larvæ of saw-flies). The caterpillars were cutworms (*Agrotis* and *Nephelodes violans*), and in several cases such bristly larvæ as *Spilosoma*. The parasitic wasps were Ichneumonidæ and scoliid wasps (*Tiphia inornata*). Ants are

FIG. 38.—Mockingbird.

a characteristic element of the food. In the present instance they included *Lasius*, *Tetramorium*, *Formica subsericea*, and *Camponotus pennsylvanicus*. The coleopterous food is interesting because four-fifths of it consisted of injurious beetles. The list of beetles identified is as follows:

Lachnosterna.
Anomala lucicola.
Dichelonycha.
Onthophagus pennsylvanicus.
Aphodius.
Odontota dorsalis.
Longitarsus.
Hæmonia nigricornis.
Corymbites pyrrhos.
Monocrepidius auritus.
Anisodactylus rusticus.
Brachylobus lithophilus.
Cychrus stenostomus.
Harpalus.
Chlænius.
Staphylinus cinnamopterus.
Chauliognathus.
Hister.
Tenebrionidæ.
Epicærus imbricatus.
Tanymecus confertus.

Were cherries, blackberries, and raspberries raised for market on the farm in large quantities, the host of catbirds with their highly frugivorous habits might do harm, but as this is not the case they not only cause no loss but are beneficent through their destruction of insect pests.

The brown thrasher (*Toxostoma rufum*, fig. 39), which is not common on the Marshall Hall farm, is somewhat more insectivorous than its relative the catbird. Only one stomach was collected. This contained black raspberries, cherries, a cricket, a ground-beetle, and a May-

beetle. May-beetles appear to be relished by the thrasher and are destroyed wholesale where the bird is abundant.

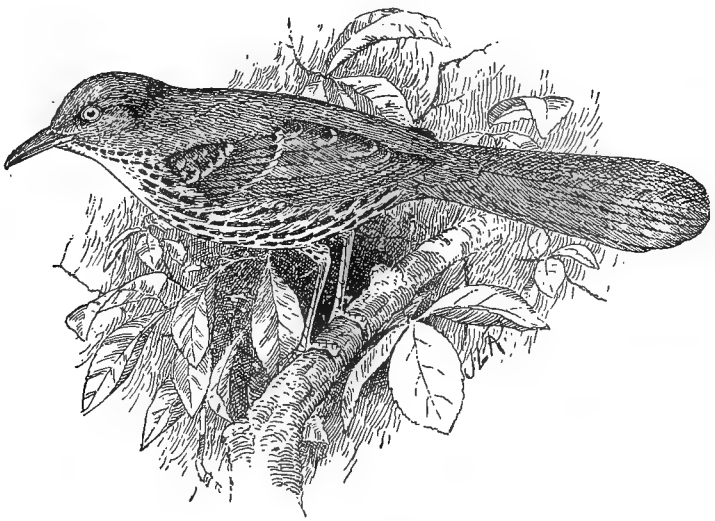


FIG. 39.—Brown thrasher.

The house wren (*Troglodytes aëdon*, fig. 40) takes no vegetable food. Twenty stomachs were collected from May to August, inclusive. They

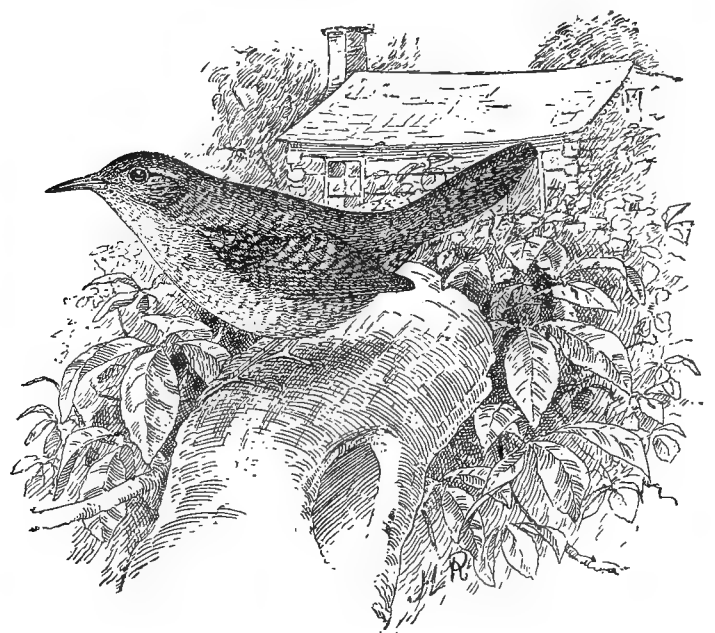


FIG. 40.—House wren.

showed the food to have been distributed as follows: Grasshoppers and crickets, 27 percent; moths, cutworms, measuring worms, and allied

larvæ, 19 percent; beetles, 11 percent, including Carabidæ, Cerambycidæ, Tenebrionidæ, Elateridæ (*Drasterius*), Scarabæidæ (*Aphodius*), Rhynchophora, and Chrysomelidæ (*Systena elongata*, etc.); bugs (true bugs—including *Myodocha serripes*—and a few leaf-hoppers), 9 percent; ants, 8 percent; May-flies, 2 percent; miscellaneous insects, 2 percent; spiders, 21 percent; and snails, 1 percent.

The winter wren (*Olbiorchilus hiemalis*) was observed hunting for insects and spiders in brush piles, but no stomachs were collected.

The long-billed marsh wren (*Cistothorus palustris*), though like the house wren it eats nothing but insects, can not be expected to help crops because of the remoteness of its marshy habitat. Five birds were collected. Spiders and beetles (*Calandra oryza*, *Donacia*, *Hippodamia maculata*) formed the major part of their food. The minor part was composed of true bugs, leaf-hoppers, flies, parasitic wasps, and ants.

One Carolina wren (*Thryothorus ludovicianus*) was collected. It had eaten caterpillars, grasshoppers, and beetles (longicorns and leaf-beetles, including *Odontota dorsalis*).

CREEPERS AND NUTHATCHES.

The brown creeper (*Certhia familiaris americana*) plays a useful part in ridding tree trunks of insect vermin. One stomach was taken. It contained such beetles as *Helops æreus* and *Bruchus hibisci*, sawflies, flying ants, spiders, and seeds of the scrub pine.

Two other beneficent gleaners of tree-trunk insects are the nuthatches (*Sitta carolinensis* and *Sitta canadensis*). Both were observed at Marshall Hall, but no specimens were collected. Prof. E. Dwight Sanderson has shown that the white-bellied nuthatch feeds on both seeds and insects. He found it eating ragweed and sunflower seeds, corn, and a very small amount of mast. His observations show it to be very fond of bugs and their eggs, and that it selects most often such Tingitidæ as *Piesma cinerea*, Reduviidæ, Coreidæ, and Jassidæ. Its beetle food includes Carabidæ, Elateridae, Scarabæidæ, and Buprestidæ. Ants (Myrmicidæ) are taken in large numbers. It also catches some parasitic wasps (Braconidæ) and frequently secures stone-flies, dragon-flies, and true flies.[a]

TITMICE.

One tufted titmouse (*Parus bicolor*) was collected July 9, 1898. It had eaten several blueberries, a longicorn beetle, and a large cutworm.

Seven Carolina chickadees (*Parus carolinensis*) were taken during February, April, July, and August. Vegetable matter—mulberry seeds, pine seeds, and ragweed seeds—was present in four stomachs. All the birds had eaten insects. One had eaten 1 bee (Andrenidæ), 2

[a] Auk, Vol. XV, pp. 144–148, 1898.

ants, 3 insect eggs, 3 spiders, and 3 caterpillars (measuring worms, Geometridæ and hairy Arctiidæ, which are usually avoided by birds). One of the stomachs examined contained katydid eggs and two others eggs of the wheel-bug. Between 200 and 300 eggs of the fall canker-worm have been found in the stomach of a black-capped chickadee and 450 eggs of a plant-louse in that of another. The eating of insect eggs is a characteristic habit of the chickadee, and makes the bird, small as it is, one of the most effective destroyers of insect pests. It is of particular value in the orchard, and every horticulturist would do well to encourage it.

KINGLETS.

The golden-crowned kinglet (*Regulus satrapa*) and the ruby-crowned kinglet (*Regulus calendula*) are useful insectivorous midgets. They were observed at Marshall Hall, but were not killed.

GNATCATCHERS.

Three blue-gray gnatcatchers (*Polioptila cærulea*) were collected. They had eaten longicorn beetles, joint-worm flies, caddis-flies, and several minute flies (unindentified Diptera).

THRUSHES.

The wood thrush (*Hylocichla mustelina*), Wilson thrush (*Hylocichla fuscescens*), hermit thrush (*Hylocichla guttata pallasi*), gray-cheeked thrush (*Hylocichla aliciæ*), and olive-backed thrush (*Hylocichla ustulata swainsoni*) were noted at Marshall Hall—the first as a breeding bird, the last four as migrants.

Three stomachs of the gray-cheeked thrush were taken May 15, 1900. They contained saw-fly larvæ, ants, caterpillars, May-flies, ground-beetles, weevils, and scarabæid beetles (*Anomala*, *Atænius*, *Lachnosterna*, and *Serica*).

Two olive-backed thrushes, also collected in May, had eaten ants (*Camponotus pennsylvanicus*), wasps (*Tiphia inornata*), ground-beetles, darkling-beetles (*Helops*), and ground-spiders (Lycosidæ).

The robin (*Merula migratoria*, fig. 41) is seen on the farm only during the colder half of the year. One bird collected in the blizzard of the third week of February, 1900, had fed on smilax berries. Field observations and the examination of stomachs collected elsewhere show that somewhat more than half of the robin's food is fruit. That which it takes at Marshall Hall, however, consists merely of wild berries. In the second week of April, 1899, 8 birds were collected. Five had eaten ground-beetles, and four, secured in a field that was being plowed, had taken large quantities of the larvæ of the ground-beetle, *Harpalus caliginosus*, which as before stated has lately been found harmful to

strawberries. The other beetles eaten were darkling-beetles (*Opatrinus*), and two clover weevils (*Sitones hispidulus* and *Phytonomus punctatus*). One robin had fed on the pupa of a dipterous insect and two had picked up cocoons of a tineid moth. Several had destroyed cutworms and army worms. Two had eaten 6 cutworms apiece.

The robin is abundant and is most useful. It is the scourge of the insects that infest the open cultivated fields of the farm. Unfortunately it usually gets little credit for its virtues, is outlawed for vices that it does not possess, and is shot in large numbers for food.

Bluebirds (*Sialia sialis*, Pl. XVII, fig. 1) breed but sparingly at Marshall Hall on account of the persecutions of the English sparrow. By twenties and thirties they visit the farm in spring, autumn, and even winter. Two birds were taken February 20, 1900, and five on the

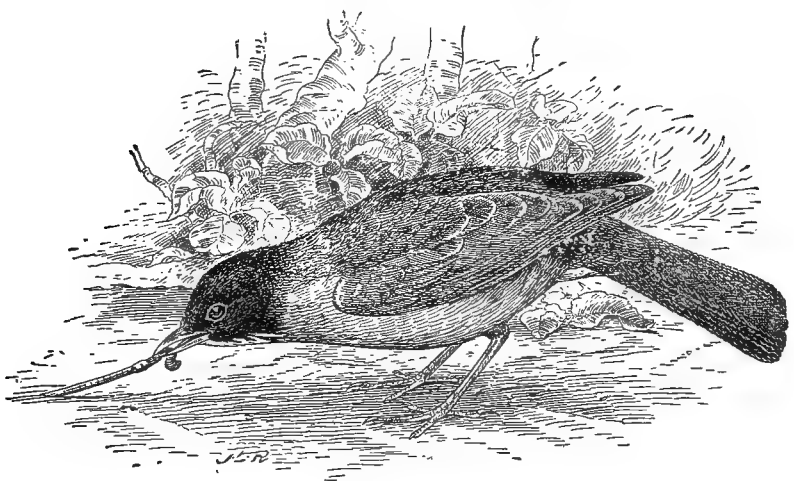


FIG. 41.—Robin.

19th of the previous November. Six of these had eaten fruit, which constituted rather more than half of all the food. It was composed of the berries of bittersweet, woodbine, cedar, sumac, and poison ivy. One had eaten 8 poison ivy berries and 25 cedar berries—apparently a pretty large dose of stimulating drugs. All had eaten insects. Their selection had fallen on such highly flavored species as ground-beetles (*Harpalus*), stink bugs (Pentatomidæ), and other bugs, including *Alydus pilosulus*. One had eaten a dung-beetle (*Aphodius*). Grasshoppers and crickets had also entered into their fare. Caterpillars, including bristly Arctiidæ and cutworms, had been the prey of all. It is a pleasant duty to report that this bird, so popular throughout the land, is, through its excellent work as a destroyer of noxious insects, well worthy the protection and encouragement it

receives. Bluebirds no longer nest on the Bryan farm, though a few pairs with their broods enter it during the summer to feed. But they were abundant there until ousted by the English sparrows, and nested all about the place. A characteristic nesting spot in an old stump on the front lawn of the house is shown in Pl. XVII, fig. 2. One of the most serious charges that can be brought against the English sparrow is the usurpation of the dooryard homes of these beautiful, gentle, and highly useful birds.

VIII.—SUMMARY.

The following conclusions are drawn solely with reference to the relationship of birds to the farmers at Marshall Hall; and while to a certain extent they indicate the general relationship of birds to agricultural interests, yet special conditions, of these particular farms as well as any others, sometimes have a modifying influence that must be taken into account.

At Marshall Hall the English sparrow, the sharpshinned and Cooper hawks, and the great horned owl are, as everywhere, inimical to the farmers' interests and should be killed at every opportunity. The sapsucker punctures orchard trees extensively and should be shot. The study of the crow is unfavorable in results so far as these particular farms are concerned, partly because of special conditions. Its work in removing carrion and destroying insects is serviceable, but it does so much damage to game, poultry, fruit, and grain that it more than counterbalances this good and should be reduced in numbers. The crow blackbird appears to be purely beneficial to these farms during the breeding season and feeds extensively on weed seed during migration, but at the latter time it is very injurious to grain. More detailed observations are necessary to determine its proper status at Marshall Hall.

The remaining species probably do more good than harm, and except under unusual conditions should receive encouragement by the owners of the farms. Certain species, such as flycatchers, swallows, and warblers, prey to some extent upon useful parasitic insects, but on the whole the habits of these insectivorous birds are productive of considerable good. Together with the vireos, cuckoos, and woodpeckers (exclusive of the sapsuckers), they are the most valuable conservators of foliage on the farms. The quail, meadowlark, orchard oriole, mockingbird, house wren, grasshopper sparrow, and chipping sparrow feed on insects of the cultivated fields, particularly during the breeding season, when the nestlings of practically all species eat enormous numbers of caterpillars and grasshoppers.

The most evident service is the wholesale destruction of weed seed. Even if birds were useful in no other way, their preservation would

still be desirable, since in destroying large quantities of weed seed they array themselves on the side of the Marshall Hall farmer against invaders that dispute with him, inch by inch, the possession of his fields. The most active weed destroyers are the quail, dove, cowbird, red-winged blackbird, meadowlark, and a dozen species of native sparrows. The utility of these species in destroying weed seed is probably at least as great wherever the birds may be found as investigation has shown it to be at Marshall Hall.

INDEX.

Accipiter cooperi, 50–51, 85.
velox, 51–52, 85.
Actitis macularia, 83.
Ægialitis vocifera, 83.
Agelaius phoeniceus, 95–96.
Aix sponsa, 80.
Ammodramus henslowi, 97.
sandwichensis savanna, 97.
savannarum passerinus, 13, 44, 97.
Ampelis cedrorum, 17, 99.
Anas boschas, 80.
obscura, 80.
Antrostomus vociferus, 91.
Ants, 32–34.
Aquila chrysaëtos, 85.
Ardea cærulea, 81.
herodias, 81.
virescens, 81.
Ardetta exilis, 81.
Arenaria morinella, 83.
Asio accipitrinus, 86.
Astragalinus tristis, 75–76, 97.
Aythya affinis, 80.
americana, 80.
marila, 80.
vallisneria, 80.
Baldpate, 80.
Beans, lima, 26.
string, 25.
Bee, honey, 36–37.
Bees and wasps, 39–40.
Beetle, flea, 25, 26, 30.
ground, 37–38.
leaf, 26, 27.
locust leaf-mining, 29–30.
potato, 25.
soldier, 37.
tiger, 37.
tortoise, 25–26.
twelve-spotted cucumber, 26, 27.
Birds, distribution, 12–20.
Birds eating ants, 34.
bees and wasps, 39.
blueberries, 61.
cherries, 56.
elderberries, 60–61.
grasshoppers, 32.
ground-beetles, 38.
locust leaf-mining beetles, 30.
melons, 57–58.
mulberries, 59.
parasitic wasps, 40.
raspberries and blackberries, 60.
Birds eating strawberries, 55–56.
various wild fruits, 62.
weed seed, 71.
weevils, 35.
wild cherries, 61.
that depend on cover, 15–17.
that feed in open fields, 12–15.
Bittern, least, 81.
Blackberries, 60.
Blackbird, crow, 14, 47–48, 53, 66–68, 77, 96.
red-winged, 95.
rusty, 96.
Blackbirds, 14, 47, 77.
Blueberries, 61.
Bluebird, 109–110.
Bobolink, 95.
Bobwhite, 13, 69–70, 78, 83–85.
Bonasa umbellus, 85.
Braconids, 40–41.
Branta canadensis, 80.
Bubo virginianus, 52, 86.
Buffle-head, 80.
Buteo borealis, 85.
lineatus, 85, 86.
platypterus, 85, 86.
Butterfly, cabbage, 27.
mourning-cloak, 87.
skipper, 87.
Buzzard, turkey, 53–54, 85.
Cabbage, 26.
Cabbage bug, 26.
worm, 26.
Caddis-fly, 25.
Canvas-back, 80.
Cardinal, 77, 98.
Cardinalis cardinalis, 77, 98.
Carpodacus purpureus, 76–77, 97.
Carrion, 53–54.
Catbird, 17–18, 47, 104–105.
Caterpillars, 48–49.
Cathartes aura, 53–54, 85.
Cedar bird, 17, 99.
Ceophlœus pileatus, 88.
Certhia familiaris americana, 107.
Ceryle alcyon, 87–88.
Chætura pelagica, 91.
Charitonetta albeola, 80.
Chat, yellow-breasted, 103.
Cherries, cultivated, 56.
wild, 61.
Chickadee, Carolina, 77, 107–108.
Chordeiles virginianus, 91.
Circus hudsonius, 54, 85, 86.

Cistothorus palustris, 107.
Clangula clangula americana, 80.
Coccyzus, americanus, 87.
erythrophthalmus, 87.
Colaptes auratus, 88, 90–91.
Colinus virginianus, 13, 69–70, 78, 83–85.
Colymbus auritus, 79.
Compsothlypis americana usneæ, 103.
Contopus virens, 91.
Coot, 81.
Corn, 36, 38, 65–70.
Corvus americanus, 14, 47–48, 50, 53, 57–58, 65–66, 94.
ossifragus, 14, 94.
Cowbird, 95.
Crane-flies, 21–22.
Crayfish, 9.
Creeper, brown, 107.
Crops infested by insects, 24–28.
Crossbill, red, 97.
white-winged, 97.
Crow, 14, 47–48, 50, 53, 57–58, 65–66, 94.
fish, 14, 94.
Crow blackbird, 14, 47–48, 53, 66–68, 77, 9°.
Cuckoo, black-billed, 87.
yellow-billed, 87.
Cutworms, 32.
Cyanocitta cristata, 93–94.
Cyanospiza cyanea, 98.
Dafila acuta, 80.
Dendroica, 104.
Dendroica, æstiva, 103.
cærulescens, 103.
coronata, 103.
discolor, 103.
dominica, 103.
maculosa, 103.
palmarum hypochrysea, 103.
pensylvanica, 103.
striata, 103.
vigorsi, 103.
virens, 103.
Dolichonyx oryzivorus; 95.
Doryphora 10-lineatus, 25.
Dove, mourning, 13–14, 77–78, 85.
Dryobates pubescens, 47, 88.
Duck, black, 80.
lesser scaup, 80.
scaup, 80.
wood, 80.
Eagle, bald, 50, 85.
golden, 85.
Ectopistes migratorius, 85.
Elderberries, 60–61.
Empidonax virescens, 91, 92.
Falco sparverius, 85, 86.
Finch, purple, 76–77, 97.
Fireflies, 37.
Fish, 53.
Flicker, 88, 90–91.
Flies, 36, 39.
Flycatcher, acadian, 91, 92.
great crested, 91, 93.
scissor-tailed, 91.
Food, insect, 21.
vertebrate, 50–53.
Food of nestlings 43.
Fruit, 55–65.
Fruit, cultivated, 55.
miscellaneous, 56–57, 61–62.
wild, 58.
Fulica americana, 81–82.
Galeoscoptes carolinensis, 17–18, 47, 104–105.
Gallinago delicata, 83.
Game, 50–52.
Gavia imber, 80.
lumme, 80.
Geothlypis formosa, 103.
trichas, 103.
Glasses used for field work, 43–44.
Gnatcatcher, blue-gray, 108.
Golden-eye, 80.
Goldfinch, 75–76, 97.
Goose, Canada, 80.
Grain, 65–70.
Grapes, 57.
Grasshoppers, 32, 48–49.
Grebe, horned, 79.
pied-billed, 79.
Ground-beetles, 37–38.
Grouse, ruffed, 85.
Gull, herring, 80.
ring-billed, 80.
Haliæetus leucocephalus, 50, 85.
Harelda hyemalis, 80.
Hawk, broad-winged, 85, 86.
Cooper, 50–51, 85.
marsh, 54, 85, 86.
red-shouldered, 85, 86.
red-tailed, 85.
sharpshinned, 51–52, 85.
sparrow, 85, 86.
Helmitherus vermivorus, 103.
Helodromas solitarius, 83.
Heron, black-crowned night, 81.
great blue, 81.
green, 81.
little blue, 81.
snowy, 81.
Herons, 9.
Hirundo erythrogastra, 46, 98.
Hummingbird, ruby-throated, 91.
Hydrochelidon nigra surinamensis, 80.
Hylocichla aliciæ, 108.
fuscescens, 108.
guttata pallasi, 108.
mustelina, 108.
ustulata swainsoni, 108
Ichneumon flies, 40.
Icteria virens, 103.
Icterus galbula, 96.
spurius, 17, 44–45, 96.
Indigo bird, 98.
Insect food, 21–42.
Insects, destructive, 30–36.
proportion contained in bird stomachs, 41.
shrubs infested by, 28–30.
trees infested by, 28–30.
useful, 36–41.
Jay, blue, 93–94.
Junco, 97.
Junco hyemalis, 97.
Killdeer, 83.
Kingbird, 17, 91–92.
Kingfisher, 87–88.

Kinglet, golden-crowned, 108.
ruby-crowned, 108.
Lady-birds, 38–39.
Lanius ludovicianus, 54, 100–102.
Lark, horned, 93.
Larus argentatus, 80.
delawarensis, 80.
Loon, 80.
red-throated, 80.
Lophodytes cucullatus, 80.
Loxia curvirostra minor, 97.
leucoptera, 97.
Mallard, 80.
Mammals, 54–55.
Mareca americana, 80.
Martin, purple, 47, 98.
May-beetle, 32.
May-flies, 22–24.
Meadowlark, 12, 77, 94–95.
Megascops asio, 86.
Melanerpes carolinus, 88.
erythrocephalus, 88, 90.
Meleagris gallopavo fera, 85.
Melons, 27, 57–58.
Melospiza lincolni, 97.
melodia, 16, 97.
Merganser, hooded, 80.
red-breasted, 80.
Merganser serrator, 80.
Merula migratoria, 108–109.
Mice, 54–55.
Mimus polyglottos, 104.
Mniotilta varia, 103.
Mockingbird, 104.
Molothrus ater, 95.
Moths, 36.
Mulberries, 59–60.
Murre, Brünnich, 80.
Muscivora forficata, 91.
Myiarchus crinitus, 91, 93.
Nestlings, food, 43–49.
Nettion carolinensis, 80.
Night-hawk, 91.
Nuthatch, red-breasted, 107.
white-breasted, 107.
Nycticorax nycticorax nævius, 81.
Oak scale, 36.
Oats, 66, 68, 69.
Odontota dorsalis, 29–30.
Olbiorchilus hiemalis, 107.
Old-squaw, 80.
Olor columbianus, 80.
Oriole, Baltimore, 96.
orchard, 17, 44–45, 96.
Osprey, 85.
Otocoris alpestris, 93.
Oven-bird, 103.
Owl, barred, 86.
great-horned, 52, 86.
screech, 86.
short-eared, 86.
Pandion haliaëtus carolinensis, 85.
Parus bicolor, 107.
carolinensis, 77, 107–108.
Passer domesticus, 17, 68–69.
Passerella iliaca, 97.
Peas, 27.
Pellets ejected by crows, 63.
by shrikes, 102.
Pewee, wood, 91–92.
Philohela minor, 82–83.
Phoebe, 91, 92–93.
Pigeon, passenger, 85.
Pintail, 80.
Pipilo erythrophthalmus, 98.
Piranga erythromelas, 98.
rubra, 98.
Plant lice, 27, 29, 39.
Podilymbus podiceps, 79.
Poison ivy, 62.
Polioptila cærulea, 108.
Pœcetes gramineus, 97.
Porzana carolina, 81.
Potato, sweet, 25–26.
white, 25.
Potato-beetle, 25.
Poultry, 50–52.
Progne subis, 47, 98.
Querquedula discors, 80.
Quiscalus quiscula, 14, 47–48, 53, 66–68, 77, 96
Quiscalus quiscula æneus, 77.
Rabbits, 55.
Rail, sora, 81.
Raspberries, 60.
Redhead, 80.
Redstart, 103.
Regulus calendula, 108.
satrapa, 108.
Riparia riparia, 46–47, 98.
Robin, 108–109.
Rose-chafer, 31–32, 87.
Sandpiper, solitary, 83.
spotted, 83.
Sapsucker, yellow-bellied, 88–90
Sawflies, 29.
Sayornis phoebe, 91, 92–93.
Scolecophagus carolinus, 96.
Seeds, distribution by birds, 62–65.
weed, 70–71.
Seeds found in crows' pellets, 63–64.
Seiurus aurocapillus, 103.
motacilla, 103.
noveboracensis, 103.
Setophaga ruticilla, 103.
Shoveller, 80.
Shrike, loggerhead, 54, 100–102.
Shrubs infested by insects, 28–30.
Sialia sialis, 109–110.
Siskin, pine, 97.
Sitta canadensis, 107.
carolinensis, 107.
Smilax, 58–59.
Snipe, Wilson, 83.
Soldier-beetles, 37–38.
Sparrow, chipping, 15–16, 97
English, 17, 68–69.
field, 15, 97.
fox, 97.
grasshopper, 13, 44, 97.
Henslow, 97.
Lincoln, 97.
savanna, 97.
song, 16, 97.
tree, 97.

Sparrow, vesper, 97.
white-throated, 97.
Sparrows, distribution, 13, 15–17.
weed destruction, 72–75.
Spatula clypeata, 80.
Sphyrapicus varius, 88–90.
Spinus pinus, 97.
Spizella monticola, 97.
pusilla, 15, 97.
socialis, 15–16, 97.
Stalk-borer, 36.
Stelgidopteryx serripennis, 98.
Sterna hirundo, 80.
Strawberries, 38, 55–56.
Sturnella magna, 12, 77, 94–95.
Swallow, bank, 46–47, 98.
barn, 46, 98.
rough-winged, 98.
white-bellied, 98.
Swallows, 99.
Swan, whistling, 80.
Swift, chimney, 91.
Syrnium varium, 86.
Tachycineta bicolor, 98.
Tanager, scarlet, 98.
summer, 98.
Teal, blue-winged, 80.
green-winged, 80.
Termites, 34.
Tern, 80.
black, 80.
Thrasher, brown, 105–106.
Thrush, gray-cheeked, 108.
hermit, 108.
olive-backed, 108.
Wilson, 108.
wood, 108.
Thryothorus ludovicianus, 107.
Tiger-beetles, 37–38.
Titmouse, tufted, 107.
Tobacco, 27–28, 36.
Tobacco worm, 27–28, 41.
Tomatoes, 57.
Topography, Bryan farm, 10–20.
Hungerford farm, 20–21.
Totanus flavipes, 83.
Towhee, 98.
Toxostoma rufum, 105–106.
Trees infested by insects, 28–30.
Troglodytes aëdon, 45–46, 106–107.
Turkey, wild, 85.
Turnstone, 83.
Tyrannus tyrannus, 17, 91–92.
Uria lomvia, 80.
Vireo gilvus, 102.
Vireo noveboracensis, 102.
olivaceus, 102.
Vireo, red-eyed, 102.
warbling, 102.
white-eyed, 102.
Warbler, black and white, 103.
black-poll, 103.
black-throated blue, 103.
black-throated green, 103.
Canadian, 103.
chestnut-sided, 103.
hooded, 103.
Kentucky, 103.
magnolia, 103.
myrtle, 103.
northern parula, 103.
palm, 104.
pine, 103.
prairie, 103.
yellow, 103.
yellow palm, 103.
yellow-throated, 103.
Wilson, 103.
worm-eating, 103.
Warblers, 103–104.
Wasps, parasitic, 40–41.
Wasps and bees, 39–40.
Water-thrush, 103.
Louisiana, 103.
Webworm, fall, 28–29.
Weed destruction by native sparrows, 72–75.
other birds, 75.
Weed seed, 70–71.
extent of destruction, 78–79.
Weed seed eaten, 71.
eaters, 71.
Weevils, 34–35.
Wheat, 66, 68, 69–70.
Whip-poor-will, 91.
Wilsonia canadensis, 103.
mitrata, 103.
pusilla, 103.
Woodcock, 82–83.
Woodpecker, downy, 47, 88.
pileated, 88.
red-bellied, 88.
red-headed, 88, 90.
Wren, Carolina, 107.
house, 45–46, 106–107.
long-billed marsh, 107.
winter, 107.
Yellowlegs, 83.
Zenaidura macroura, 13–14, 77–78, 85.
Zonotrichia albicollis, 97.

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BOBWHITE IN POTATO FIELD.

U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF BIOLOGICAL SURVEY—BULLETIN No. 21

C. HART MERRIAM, Chief

THE BOBWHITE AND OTHER QUAILS OF THE UNITED STATES IN THEIR ECONOMIC RELATIONS

BY

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WASHINGTON

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Biological Survey,
Washington, D. C., July 31, 1905.

Sir: I have the honor to transmit herewith, for publication as Bulletin 21 of the Biological Survey, a report on the quails of the United States and their economic value, by Sylvester D. Judd. The quails as a group are perhaps better known through the country than any other birds. From the time of the first settlements in New England and Virginia till the present day they have been favorite objects of pursuit by sportsmen, and are widely known as table delicacies.

The chief purpose of the present paper is to consider the quails in their economic relations to the farmer—relations not so well understood as they deserve to be. Investigation shows the birds to be no less important in their economic than in their other relations to man. They are found to be exceedingly valuable allies of agriculture because of the quantity of noxious insects and weed seeds they destroy, while the harm they do is insignificant.

I am indebted to my assistant, E. W. Nelson, for preparing the introduction and critically reading the text, and to the Bureau of Entomology for the identification of many of the insects mentioned.

Respectfully,

C. Hart Merriam,
Chief Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
The bobwhite (*Colinus virginianus*)	9
Call notes	10
Breeding habits	11
General habits	13
Bobwhite as an ally of the farmer	14
Bobwhite as an asset of the farm	15
Bobwhite as an article of food	16
Bobwhite as an object of sport	16
Esthetic value of bobwhite	17
Decrease of bobwhite	18
Legislation in behalf of bobwhite	19
Measures for preservation and propagation	20
Food habits	27
Grain as food	28
Weed seeds as food	31
List of weed seeds eaten	34
Mast and pine seeds as food	35
Fruit as food	35
List of fruits eaten	37
Leaves and buds as food	37
Insects as food	37
Beetles eaten	38
List of beetles eaten	41
Bugs eaten	42
List of bugs eaten	42
Grasshoppers and allied insects eaten	43
Caterpillars eaten	44
List of caterpillars eaten	45
Miscellaneous animal food	45
Food of the young	45
Masked bobwhite (*Colinus ridgwayi*)	46
California quail (*Lophortyx californicus*)	47
Food habits	49
Insect and other animal food	49
Vegetable food	50
Fruit	50
Grain	51
Leaves	52
Weed seeds	52
Food of the young	55
Gambel quail (*Lophortyx gambeli*)	56
Food habits	57
Mountain quail (*Oreortyx pictus*)	58
Food habits	59
Scaled quail (*Callipepla squamata*)	61
Food habits	61
Mearns quail (*Cyrtonyx montezumæ mearnsi*)	63
Food habits	63

LIST OF ILLUSTRATIONS.

PLATES.

		Page.
PLATE I.	Bobwhite	Frontispiece.
II.	Gambel quail	56

TEXT FIGURES.

FIG. 1.	Witch grass seed	31
2.	Crab grass seed	32
3.	Knot grass seed	33
4.	Mayweed seed	53
5.	Alfilaria seed	53
6.	Black mustard seed	53
7.	Chickweed seed	54
8.	Geranium seed	54
9.	Sorrel seed	54
10.	Chess seed	55

THE BOBWHITE AND OTHER QUAILS OF THE UNITED STATES IN THEIR ECONOMIC RELATIONS.

INTRODUCTION.

The quails of the United States, because of their interesting habits and marvelous diversity of form and color, are a notably attractive group. All are handsome birds, but the most striking and beautiful species live in the Southwest and on the Pacific coast. Seven species occur within our borders, but only one in the Eastern States. The others are widely distributed from Texas to California and Oregon. Their range was, and still is, continuous along the entire southern border of the country from the Atlantic to the Pacific; but there is an irregular belt along the northern border and a large area in the interior, comprising the Great Plains, the northern three-fourths of the Great Basin, and the Rocky Mountains, in which they appear to have been originally wanting.

With few exceptions our quails welcome the extension of agriculture, and the added food supply in farmed areas results in an increase of their numbers. This is equally true of the bobwhite of the East, and of some of the desert species of the West. So fully does the bobwhite appreciate the advantages of the farm that its range has increased with the extension of the cultivated area, especially west of the Mississippi.

The quails, because of their cheerful habits, their beauty, and their value as food, are usually welcome on the farm; but their real value to agriculture is not yet generally understood. The investigations of the Biological Survey show that these birds, with rare exceptions, are not only harmless, but that usually they are very useful to agriculture. This is particularly true of the bobwhite, which constantly feeds on injurious weed seeds and insects, and thus renders valuable service to the farmer. In return for this good service it is but fair that these birds should be treated with friendly care and interest.

The well-known bobwhite is the only quail indigenous to the Eastern United States, where it ranges from southern New England to Florida and Texas; but owing to climatic influences the birds of Florida and of Texas differ enough to be distinguished as geographic races. Wherever it occurs, however, the bobwhite has the same call,

and varies but little in habits. A closely related bird, the masked bobwhite, inhabited southern Arizona until within a few years. Owing to dry seasons and the overstocking of its home with cattle, this bird is now supposed to be extinct within our borders; but some probably exist in parts of Sonora, Mexico.

Although bobwhites are handsome birds, yet they are the plainest quail in the United States except the 'cotton top' or scaled quail of the deserts of southern Texas and Arizona. The latter is slaty bluish on the upper parts, which are ornamented with large scale-like markings, and has a whitish crest.

The most bizarre and curious of all is the Mearns quail of the high, broken plains and mountain slopes of southwestern Texas, southern New Mexico and Arizona. It is short and round bodied, like a little guinea hen, and this superficial likeness is increased by brilliant round white spots ornamenting the dark sides. It is the gentlest of all the quails and is so unsuspicious that when a person encounters one it often walks unconcernedly about or stands looking curiously at the newcomer, when it is not infrequently killed with a stick or stone, a characteristic which, among the people where it lives, has earned for it the name of 'Fool Quail.'

The Gambel quail is a habitant of the southwestern desert region, where it ranges the brushy foothills and the valleys along water-courses. It is a beautiful bird, the head handsomely marked and adorned with a jet-black recurving crest, and the flanks bright chestnut, brilliantly streaked with white. This quail, one of the most conspicuous and pleasing forms of desert life, is numerous wherever it can find sufficient food and water. For ages it has claimed many a remote watering place as its own, but it welcomes the settler and finds additional shelter and food in his irrigated fields. Under the new conditions its numbers increase and it repays the favors received by becoming semidomesticated. Its presence adds a touch of bright color and animation to the dreary surroundings of many a lonely desert ranch.

The California valley quail belongs entirely to the Pacific coast, and probably is the most beautiful of the smaller gallinaceous birds of the world. It resembles the Gambel quail in its recurving black crest and general appearance, but exceeds that bird in the richness of its colors and markings. It is abundant in most parts of California.

The California mountain quail, the largest and one of the handsomest of this group, inhabits the wooded mountains of the Pacific coast, and bears a superficial resemblance to the red-legged partridge of Europe. Like the Mearns quail, its haunts are usually more remote from cultivated lands than are those of the other species.

The services to agriculture of the western quails, while in most

cases appreciable, are far less valuable than those of bobwhite, mainly because the birds are much less insectivorous. Moreover, the California valley quail sometimes damages the grape crop.

The value of a single game bird is of course small, and it is from this narrow point of view that its relation to the community is usually considered. When, however, the value of any important species is worked out the result is surprising. It has been conclusively demonstrated that in Virginia and North Carolina alone the common quail annually destroys many tons of noxious insects and weed seeds. The great value of this service must be apparent to all who appreciate the never-ending warfare between the farmer and his hydra-headed enemies, the insects and weeds. The food value also of the quail is great, and the health and pleasure derived from their pursuit has resulted in the investment of millions of dollars. When it is generally understood that by judicious effort the numbers of these useful birds may be greatly increased, with a proportionate benefit to all concerned, it is hoped that efforts to this end will not be long delayed.

THE BOBWHITE.

(*Colinus virginianus.*)[a]

The bobwhite is one of the most widely distributed and popular game birds of the United States, but in many places it is suffering ruthless extermination. Sportsmen, farmers, legislators, and ornithologists, as well as the friends of birds in general, should interest themselves in the problem of its preservation. In the Northern, Western, and Middle States it is commonly known as 'quail,' in the Southern States as 'partridge.' This tends to confusion, since in New England and northern New York the name 'partridge' is commonly applied to the ruffed grouse. Both names were brought to America by English colonists from their Old World homes, where they are applied to species not originally inhabiting this continent. The name 'bobwhite' is from the familiar call note of the bird.

In some of its characteristics bobwhite differs strikingly from other members of the family. For example, the crest—a well-developed adornment of several closely related American quails—in bobwhite is invisible except when the bird is excited.

The common bobwhite ranges more or less generally over the eastern half of the United States and southern Ontario, except in the colder, mountainous parts, from southern Maine to northern Florida, and west to South Dakota, Nebraska, Kansas, and Texas. In addi-

[a] The name is used here in its broad sense to cover the typical bird of the Eastern States, *Colinus virginianus*, and the two subspecies, the Florida bobwhite (*C. v. floridanus*) and the Texas bobwhite (*C. v. texanus*).

tion, colonies have been introduced and found to thrive in various localities in Colorado, New Mexico, Utah, Idaho, California, Oregon, Washington, and the island of Jamaica. South of the home of the typical bird, just outlined, bobwhites have a wide range, occupying Florida, western and southern Texas, Cuba, and a large part of Mexico, and extending even beyond the border of Guatemala. Owing chiefly to climatic influences the southern birds differ more or less from the northern ones. The masked bobwhite (*Colinus ridgwayi*), a closely related but separate species, once lived in extreme southern Arizona and the adjoining part of Sonora, but now it is probably extinct within our borders. With this exception all of the bobwhites from Canada to Guatemala and Cuba, according to E. W. Nelson, belong to a single species modified by environment into a considerable number of forms, some of which are strikingly different from the birds of the United States. The Florida bobwhite, which is peculiar to the peninsula of Florida, is smaller and darker than the northern bird. The Texas bobwhite of western Texas and northeastern Mexico is about the same size as the northern one, but is paler and has a light rufous collar below the black band and bordering the white throat patch. The Salvin bobwhite from the southern border of Mexico is very unlike the common bird of the United States, most of the head, neck, and breast being plain black and the rest of the underparts plain rufous.

The present account is limited to the bobwhites of the United States, including the Texas and Florida forms. The writer's field work in this connection has been principally in New Jersey, Virginia, and Maryland—on a farm at Marshall Hall, Md., which is directly across the Potomac from Mount Vernon.

CALL NOTES.

In the field the nuptial call note of the cockbird is an infallible guide to its identity. This familiar challenge, sounding to the sportsman like '*bob white*,' '*bob-bob-white*,' and to the farmer like '*more wet*' or '*no more wet*,' is by no means the only note of the species during the breeding season. It was the good fortune of the writer during the last week of June, 1902, to hear the nesting note and other calls. Again and again the cock left his distant perch, where he had been whistling 'bob white,' and, still calling, approached the nest on the bank of a little sluggish briery run between open fields. When within 50 yards of his mate he uttered the rally note, so thrilling to the sportsman in the fall, '*ka-loi-kee*,' which the hen often answered with a single clear whistle. Then followed a series of queer responsive 'caterwaulings,' more unbirdlike than those of the yellow-breasted chat, suggesting now the call of a cat to

its kittens, now the scolding of a caged gray squirrel, now the alarm notes of a mother grouse blended with the strident cry of the guinea hen. As a finale sometimes came a loud rasping noise, not unlike the effort of a broken-voiced whip-poor-will. The favorite calling stations were rail fences at a height from 5 to 10 feet, and the limbs of trees along fence rows. One bird whistled in a tulip tree at least 35 feet from the ground. H. H. Miller reports that April 25, 1903, was the earliest date of nuptial notes at Sandy Spring, Md. After the breeding season the bird discontinues this characteristic call. During August 19–21, 1902, it was heard only on one occasion at Marshall Hall, where the birds are numerous, and ceased after a dozen repetitions. Edward A. Preble, of the Biological Survey, has recorded the 'bob-white' call at Wilmington, Mass., as late as October 20.

The notes of the bobwhite in fall and winter have been described by many writers. The following quotation from Mr. Sandys gives an admirable description of the call notes of a covey that has been scattered by the sportsman and is trying to reassemble for the night, a notation so accurate as instantly to recall the notes to one who has heard them: "Over the brow of a hill comes the low, tender call of the hen to her youngsters, '*ka-loi-kee*, *ka-loi-kee;*' and, perhaps, from the broomsedge beside the observer comes the loud vibrant answer, '*whoil-kee.*'" This call is usually sounded in the late afternoon, but December 31, 1901, at Woodbridge, Va., a scattered flock was heard calling persistently in the morning.

On one occasion the writer watched a bobwhite whistling from a fence rail 10 feet away. At such close range the whistle lost all its melody and became a nasal shriek which was almost painful to the ear. It was repeated on an average five or six times a minute and consisted of either two or three notes, of which the first was so low as to be inaudible a hundred yards away, and the last was strikingly louder. The mode of delivery was peculiar; sitting in a normal, erect position the bird emitted the first note, then depressing the tip of the bill almost to touch its breast, with a motion as though hiccoughing, it gave the second, then throwing back its head and pointing its bill skyward it uttered the explosive, far-reaching third note.

BREEDING HABITS.

The nesting time of bobwhite in each section of the bird's range is usually limited to a fairly well-defined period, but varies considerably in the time of beginning, the difference being partly seasonal and partly regional. About Washington, D. C., the coveys usually break up the first part of May, one covey being seen in 1899 as late as May 9. In 1902 the first nest with eggs was found at Marshall Hall

on May 29, and the first downy chicks on July 6. Between the end of June and last of August seven pairs of birds were found there which had recently mated or were incubating. This was shown by the fact that the cock birds were flushed thirty-six times and the hens only four times. During the same season five nests were found between July 15 and 19 at Sandy Spring, Md., less than 20 miles away. One of these nests contained 24 eggs. Even larger clutches are recorded, and one nest found at Woodstock, Ohio, is reported to have contained 42 eggs.[a] Such large clutches probably are the product of more than one bird. In 1903 nesting appeared to be later than in 1902, as the first eggs found were discovered July 10. The farmers at Marshall Hall say that they usually find the first downy chicks during wheat harvest, usually the last week of June. A number of broods of chicks were seen about Marshall Hall from July to September.

The newly hatched young have chocolate-streaked heads, and resemble small black and red bantam chicks. Whenever these newly hatched chicks remain motionless their protective coloration renders them invisible unless one makes a most careful search.

From information at hand it appears that the main breeding season for bobwhite in the Northern States, including the country about Washington, D. C., is during May, June, and the first half of July. Florida birds begin to breed regularly the first of April (though some are much earlier), and continue nesting till well into June. Texas birds nest mainly in April and May, but some nest as late as September. Throughout its range some of the birds breed earlier and others later than the main body of the species, and the occurrence of second or even third broods may lengthen the season. Robert Ridgway found a clutch of freshly deposited eggs in southern Illinois on October 16, and H. C. Munger found another set in Missouri in January, the parent being afterwards found frozen on the nest. Authentic records from various parts of its range show that bobwhite has been known to breed, at least occasionally, somewhere in its range every month of the year except December. This seems to prove that under certain circumstances bobwhite, like the domestic hen, will lay a clutch of eggs at any time of year.

The occasional presence with the female of young of two or three sizes appears to show that at least two broods are sometimes raised in a season, but we lack definite information on this subject. Major Bendire gives twenty-four days as the period of incubation. The male is reported as sometimes assisting in this duty.

[a] Forest and Stream, X, p. 399, 1878.

GENERAL HABITS OF THE BOBWHITE.

The habits of bobwhite, like those of many other birds, vary considerably, and the following, observed by E. W. Nelson, is a case in point. In 1875 the Wabash bottoms near Mount Carmel, Ill., were covered with a magnificent forest, quite tropical in the size and luxuriant growth of trees and other vegetation. Scattered here and there through the forest were small clearings planted to corn. Bobwhites were found about all of these clearings, and the males were commonly heard calling from the tops of tall trees in the edge of the bordering forest, and on more than one occasion were stalked and shot in the midst of the woods from tree tops more than 100 feet from the ground. When flushed in the cornfields the coveys dashed away into the forest, where they took refuge in the tree tops, thence sending forth their rallying call notes.

There appears to be a tendency among bobwhites, at least in some regions, to a local migration. In certain sections, as in Virginia and Maryland, they commonly leave their summer homes on the approach of winter and congregate near the larger watercourses. In an old number of the American Sportsman Lewis refers to this fall movement, and says: "At this period the birds are said to be running or traveling, and will not lie to a dog; and to pursue is lost time, as it will be found utterly impossible to keep up with them, no matter with what speed you attempt it."

The habits of the bobwhite during the hunting season are well known. The birds move about most actively and feed in the early morning and late afternoon. The best shooting is to be had the hour before sunset, in the places where the birds have decided to spend the night. They roost on the ground, forming a solid ring with tails in and heads out. In Virginia and Maryland the roosting places are almost never in the woods, though in Mecklenburg County, Va., the writer has found them in grassy, briery little clearings among pine woods. At Marshall Hall the birds were found roosting in the edges of woodland, orchards, patches of ragweed in wheat stubble, cornfields, truck plats, broomsedge, dewberry and blackberry tangles, pastures, and fence corners. In Massachusetts Edward A. Preble found no roosts in the open fields, but found them among scrub oaks and in tall pine forests. Bobwhites habitually use a roosting ground again and again. A covey of a dozen, found the middle of November, 1899, at Marshall Hall, resorted to a corner of a peach orchard for eight consecutive nights, and during December, 1902, a covey of fifteen on the Roanoke River bottom used a narrow strip of cockleburr, ragweed, and smartweed for ten consecutive nights. It is interesting to note that, although quail seek the woods for shelter from enemies during the day, they generally regard the open as safer at night.

It is the general opinion that with the on-coming of winter the bobwhite is found less often in the open fields, where withered herbaceous plants afford but scant protection from enemies, than in dense bushy briery coverts and woods.

In Maryland and Virginia the scattered and depleted coveys after the shooting season evidently unite into large bevies. Their favorite resort in severe weather is a bank with southern exposure and suitable food supply. At Marshall Hall during one of the heaviest snowfalls of the season, when the Potomac was frozen over and the thermometer near zero, a covey was always to be found on the southeast side of a steep bank bordering a large swamp. Here the birds found food and warmth, for the rays of the sun fell on this slope so directly that even when the snow elsewhere lay from 3 to 6 inches deep it was here melted or remained only in patches. It was noticeable that when snow was on the ground the birds ventured only a few rods from cover, a fact that apparently indicated their appreciation of danger from the numerous hawks and foxes. At Kinsale, Va., the writer found bobwhites crossing open fields when there was an inch or two of snow, though for the most part they kept close to cover. In April and May the birds again venture out into the open, and they breed when vegetation is sufficiently grown to conceal the nests.

At Marshall Hall little oval pits in dry soil, in which quail had been dusting, were found in various situations, usually under cover of weeds and bushes about the fields. Dusting is a part of the toilet of all gallinaceous and many other birds, and may also be a protection against vermin.

BOBWHITE AS AN ALLY OF THE FARMER.

In summing up the relations of the bobwhite to agriculture it will be well to emphasize certain facts developed by our investigation of its food habits. In the first place, careful observations at Marshall Hall, where the acreage under cultivation is large and the bobwhite abundant, and less extended investigations elsewhere afford no evidence that the species does appreciable injury to crops of grain or fruit. Further, its habit of destroying weed seeds is of much economic importance. For instance, it is reasonable to assume that in the States of Virginia and North Carolina, from September 1 to April 30, the season when the largest proportion of weed seed is consumed by birds, there are four bobwhites to each square mile of land, or 354,820 in the two States. The crop of each bird holds half an ounce of seeds and is filled twice a day. Since at each of the two daily meals weed seeds constitute at least half the contents of the crop, or a quarter of an ounce, a half ounce daily is consumed by each bird. On this basis the total consumption of weed seeds by

bobwhites from September 1 to April 30 in Virginia and North Carolina amounts to 1,341 tons. It is to be remembered also that if it were not for foxes, hawks, and trespassing pot hunters the birds would be more abundant and their services correspondingly greater. Insects form about one-third of the bobwhite's diet from June 1 to August 31; and a calculation similar to the one employed above shows that 340 tons of insects are destroyed during this period.

Among the insects consumed by the bird are such very harmful pests as the Rocky Mountain locust, the chinch bug, the Colorado potato beetle, the Mexican cotton boll weevil, cutworms, the two cotton worms, and the army worm. The highly insectivorous chicks cause a proportionally greater destruction of insects than the adult birds. Further, while many other useful birds confine themselves to the woodland or swamp, or merely scout along waterways, hedges, and fence rows, the bobwhite feeds directly among field crops. In the South it is found in cotton fields; in the North it delights in the ragweed-grown wheat stubble; in the West its favorite feeding ground is corn fields, and it often spends the night there instead of flying to cover as do most birds. The facility with which it passes from field to field, either on foot or on the wing, distributes its services to an unusual degree.

BOBWHITE AS AN ASSET OF THE FARM.

Every landowner should realize the value of the bobwhite, and should demand from sportsmen a fair price for the birds killed on his property. With proper management some farms of from 500 to 1,000 acres would probably yield a better revenue from bobwhites than from poultry. Many farms in North Carolina derive a regular income from this source. This is obtained by leasing the shooting right to wealthy sportsmen, who, in localities where birds are abundant, willingly pay considerable sums for the privilege. This is probably the most profitable use to which certain poor lands in the South can be put. In some places in Maryland, Virginia, and North Carolina the sportsman often pays the landowner from 5 to 25 cents for every bird shot. In other places the farmer or his boy is hired as guide to locate the quail. In addition the sportsman pays liberally for his board and otherwise adds to the farmer's income. Wide-awake farmers appreciate the fact that the genuine sportsman pays well for his sport and should discriminate between him and the market hunter. Millions of dollars can be realized by the proper management of the quail crop of the United States. The time is perhaps not far distant when landowners will protect their game birds from foxes, injurious hawks, and human poachers as diligently as they now do their poultry. The sooner the farmer realizes the value

5112—No. 21—05 M——3

of the bobwhite and the fact that the market hunter is a bird exterminator, profiting at the landowner's expense, the better will be his chance of an income from his crop of quail.

BOBWHITE AS AN ARTICLE OF FOOD.

Perhaps no game is more generally known and liked than quail. The flesh of the bobwhite is juicy, tender, delicately flavored, easily digested, and nutritious. It is well adapted to the needs of invalids. To the farmer's table, where fresh meat is often not obtainable, this bird furnishes a welcome supply. No game is so much sought for in market, and countless numbers are sold every year. The writer knows of a single dealer in Washington who in 1902 sold 100,000 quail. Yet the supply is far short of the demand, and the price is constantly rising. In connection with the present price, which is $3 to $5 a dozen, it is interesting to recall Audubon's statement that in 1810 these birds could be bought for 12 cents a dozen and in 1831 for 50 cents.[a] Then they were on the tables of rich and poor alike.

BOBWHITE AS AN OBJECT OF SPORT.

Edwyn Sandys says of the bobwhite: "He truly is the king of his race; and not alone that, for, in the opinion of hosts of enthusiastic sportsmen, he is the best bird that flies." The well-known author T. S. Van Dyke says: "Dear little Bob White has brought more rest to the business-wearied soul, more new life to tired humanity than nearly all other American game combined." The pursuit of many kinds of game is possible only in the distant wilderness, where traveling is difficult and the exposure incident to the sport may be dangerous to health; but the pursuit of the bobwhite belongs to open, accessible country, and is not too severe for men accustomed to a sedentary life. To thousands of such men quail hunting is the yearly means of restoration, and results in a direct benefit to the community, though one not readily computed in money value. At a conservative estimate, between 300,000 and 400,000 sportsmen go out from cities every fall to hunt bobwhite, which means a large expenditure of money, much of which goes to farmers who hold shooting land. Such revenue is timely, for it comes when farm work yields small returns and employment is welcome. Where nonresident licenses are required, with fee of from $5 to $25, the State also derives a direct income from the sport.

The bobwhite deservedly stands at the head of American game birds, because it lies so well to the dog, and when flushed springs from the earth like an arrow, demanding a quick eye and a trained

[a] Ornith. Biog., I, p. 392, 1831.

touch on the trigger to bring it to bag. When, at the advance of the hunter, the covey explodes like a bomb, his skill is sharply tested if he would bring one of the whirring, meteorlike projectiles to the ground. Birds of a scattered covey are hard to find. Good authorities say that when they alight they remain quiet and compress their feathers to the body, with the result of withholding the scent. Many sportsmen, therefore, before hunting a scattered covey, give them time to run about and leave scent.

Paradoxical as it may seem, sportsmen exert a powerful influence for the protection of bobwhite. Many individuals and clubs own or lease large tracts, where they maintain the birds and shoot only the surplus. These enthusiasts assist in the enforcement of game laws, restock depleted covers, and provide food for the birds in times of scarcity. Certain clubs are organized for the purpose of holding field trials, the object of which is to test the ability of competing dogs to find and point birds. As retrieving is not required, the birds are not shot. One of the best-known patrons of field trials recently told the writer that he had not killed a bobwhite in ten years. A number of clubs control each a preserve of from 5,000 to 20,000 acres, on which no shooting is allowed—or, if permitted, is carefully regulated—and suitable measures are taken for protecting birds and facilitating their propagation. These trials are held in a score or more of States, and in some of the larger contests more than a hundred dogs are entered. Some owners of field-trial dogs have preserves of their own, stocked with hundreds of pairs of bobwhites. Thousands of live birds for the above purposes are in demand, at high prices. If the bobwhite could be domesticated and reared in captivity for sale, the enterprise would doubtless be very profitable. From these facts it is evident that the sport of hunting bobwhite contributes to the health and happiness of thousands of men, and that in various ways it can be made to add to the prosperity of farmers and others interested.

ESTHETIC VALUE OF BOBWHITE.

Much money has been spent, and well spent, merely for the enjoyment of the beauty and companionship of birds. For the protection of gulls and terns along the Atlantic coast thousands of dollars have been expended at the instance of bird lovers, in whose eyes these delicate and graceful creatures are the crowning attractions of marine landscape. In like manner the admirers of bobwhite derive esthetic pleasure from his presence. To pastoral inland scenes—woodlots in a green mist of young leaves, summer grass fields and bushy pastures, brown stubble, and skeleton cornfields—the bobwhite adds a distinctive charm—homely, but none the less attractive. As the bird

calls from the fence post or runs fearlessly across the road, the stroller can but admire its trim, alert figure and tasteful color pattern of black, white, and brown, set off with delicate tintings of blue-gray. Its mellow whistle seems a proffer of good-fellowship, investing even a solitude with cheer, while the plaintive covey-call heard in the growing darkness to summon a scattered flock to the nightly resting place is one of the tenderest of evening sounds. Because of such traits the bird has made many friends, some of whom spend time and money to insure its undisturbed presence in their neighborhood.

DECREASE OF BOBWHITE.

Every few years, on the recurrence of unusually severe winters with heavy snows which cover the food supply, great numbers of bobwhites perish, and sometimes in the northern part of its range the bird becomes almost extinct. This unnecessary loss of life could be largely prevented if landowners and others interested would scatter a little grain in suitable places. This is done in some localities, as at Sandy Spring, Md., where H. H. Miller drives over the snow-covered country, scattering grain for the starving quail. The practice is worthy of general adoption. It is necessary only while the ground is snowbound, and especially after sleet storms.

The bobwhite has taken kindly to civilization and has followed the plow of the settler into new sections, so that with the advance of the farming area in the West, and especially in the Northwest, its range has been much extended.

There is little doubt, however, that, while the bobwhite is a fairly hardy and prolific species, its numbers are decreasing in much, if not all, of its range, where not specially protected. In the early fifties Lewis reported 61 birds killed in a day to a single muzzle loader, and mentions 900 birds trapped on one estate in a season. Within the last few years the scarcity of bobwhites has been so notable that several projected field trials have been abandoned for lack of birds on which to try the dogs.

Severe winters, as already noted, are an occasional cause for a great decrease in the number of the birds, though they increase rapidly with a few succeeding good seasons. In sections where the birds are still common unlimited slaughter is often indulged in by thoughtless hunters. Recent instances of such slaughter are on record, and the following may be cited: A bag of 175 birds to three guns in eight hours in the fall of 1902 at Tiffin, Ohio,[a] another of 300 birds to a single gun in a day and a half in the fall of 1902, in Marshall County, Ky.,[b] and still another of 292 birds to three guns in a day in South

[a] Recreation, vol. 17, p. 120. [b] Ibid., vol. 19, p. 41.

Carolina during the same season.[a] The value of this bird, both to the farmer and the sportsman, renders the question of its maintenance and increase one of much importance. So assiduously is the bobwhite sought by sportsmen and market hunters that intelligent and concerted efforts are needed even to maintain its present numbers.

LEGISLATION IN BEHALF OF BOBWHITE.

In addition to natural causes, reasons for the diminished numbers of bobwhites are diversity in the open season, shooting out of season, excessive shooting in season, and unrestricted shooting and trapping for market. Lack of uniformity in laws of adjoining States, and in some cases of adjoining counties, renders their observance difficult and their enforcement often impossible. No other game bird has been the subject of so much legislation, which, beginning in New York in 1791, now extends to every State and Territory where the bird is native or has been introduced. The length of season during which the bird should be protected by law is a matter of paramount importance. It goes without saying that no shooting should be permitted during the breeding season, which must be understood to last until the young of the year are strong of wing and fully developed for the struggle for existence. Besides this the close season ought to include months of rest, during which the birds can fortify themselves for the physiological strain of the next period of reproduction. As now established the open season varies from twenty-one days in Ohio to seven months in Mississippi. In North Carolina, however, where nearly every county has its own law, the bobwhite may be shot throughout the year in five counties. Virginia has recently abolished county laws and established uniformity, an example that other States, especially Southern States, would do well to follow. It is gratifying to note that in 1903 the open seasons were shortened by New York, Illinois, Texas, and Virginia. In eight States—Maine, Rhode Island, Wisconsin, North Dakota, Montana, Colorado, Wyoming, and Utah—the bobwhite is absolutely protected for a term of years, extending to 1920 in Colorado. Two conditions justify such prohibition of shooting. First, when excessive shooting or other causes have made recuperation necessary; second, when birds just introduced into a new locality need time to establish themselves. Wherever the bird can not hold its own with an open season of three weeks absolute protection for a period of years is demanded. The length of the open season must vary with varying conditions, but in view of the general decrease of the birds there would seem to be a growing need for shortening it. The sooner Northern States limit their shooting to one month the better. Even

[a] Recreation, vol. 16, p. 372.

Southern birds can not stand the present continuous fusillade of from four to seven months, and the open season in the South should be limited to two or, at most, three months.

The slaughter of the bobwhite by sportsmen who hunt for pleasure is insignificant in comparison with that by professional market hunters. At the present time (1904), in about 25 States, the law takes cognizance of this fact by prohibiting the sale of birds killed within the State or imported from other States, and the general tendency altogether to prohibit the sale is growing each year. Every State except Mississippi forbids the sending of certain game outside the State—a restriction on the sportsman as well as the market hunter, although the privilege of carrying home a limited amount of game is often granted under a nonresident license. Fourteen States have laws, also affecting both classes, limiting a day's bag to from 5 to 50 birds. Many sportsmen and farmers would be glad if the limit were set at 12. Laws discriminating against nonresidents protect the game and benefit the landowner, provided visiting sportsmen are not barred altogether by unreasonable fees. Thirty-one States and Territories require nonresident licenses. In addition to State game laws there are certain Federal laws, the most important of which is the Lacey Act, which provides, among other things, through the Department of Agriculture, for the preservation, distribution, introduction, and restoration of game birds, and also undertakes to bring to justice persons who transport from one State to another game killed in violation of local laws. The latter clause proves effective in restricting such illegal shipments and in suppressing professional dealers that kill out of season in one State and attempt to sell in another where the season is still open. A law to prevent keeping birds in cold storage from one season to another would stop certain loopholes in the present laws and greatly aid in preserving game. An effective system of State game officials where it is lacking would aid in enforcing game laws. A number of States depend solely on county officers; but experience has shown that without a central State organization and special game wardens the law to a great extent becomes a dead letter.

MEASURES FOR PRESERVATION AND PROPAGATION.

Stringent laws against trapping the bobwhite have been enacted, but such legislation should permit legitimate trapping for purposes of propagation. One of the most important problems before game commissioners is the restocking of depleted covers. If, however, the bobwhite can be reared successfully in captivity, all trapping may be prohibited. The sporting magazines ('Forest and Stream' and 'American Field') mention cases of the bird's laying in captivity

and raising its young; and in a letter to the writer, dated September 2, 1904, G. W. Jack, of Shreveport, La., says:

> I now have a pair of quails (bobwhites) which were trapped last winter and which I keep in a large wire coop. They have made a nest in some grass and have laid about 12 or 15 eggs.
>
> The eggs were laid very irregularly, not more than two or three a week, so that by the time the nest was full the season was far advanced, which perhaps accounts for the female not sitting. The eggs were set under a hen and proved fertile, but the young were eaten by the chicken as fast as they hatched. I concluded that this irregularity or slowness in laying was the result of the lack of insect and other egg-producing food, as the birds subsist almost wholly on grain. Of late, however, they have learned to eat with much relish the yolk of an egg hard boiled.

The failure of the female to sit was probably due to the unnatural confinement in so small a space, a difficulty which could readily be remedied if attempts to raise quail were made on a large scale. Unquestionably, too, it would be necessary to feed the quail, at least during the nesting period, to a considerable extent upon animal food.

An instructive account of quail breeding in confinement appears in Forest and Stream for September 28, 1882 (p. 164). The female had been hatched and reared by a bantam hen, and this circumstance has an important bearing on experiments of this kind. It is altogether probable that bobwhites hatched and reared in this way would lend themselves to experiments in propagation far more readily than wild birds trapped for the purpose.

The Department of Agriculture obtained three pairs of bobwhites from Kansas, which after five months' captivity are almost as wild as when first caged and show no signs of mating. Experiments in the domestication of bobwhite are well worth trying, however, because of the demand from clubs and individuals for live birds to restock their grounds. So great has become the demand in recent years that it is estimated that 200,000 birds would be required annually to fill it. During the spring of 1903 the demand far exceeded the supply, even at $5 a dozen, and sometimes at twice that figure.

Success in increasing the numbers of bobwhite depends largely on controlling its natural enemies, which include snakes, foxes, weasels, minks, skunks, domestic cats, and certain hawks and owls. Several species of snakes eat its eggs and young. Writing from Texas, Major Bendire says: "The many large rattlesnakes found here are their worst enemies. One killed in May had swallowed five of these birds at one meal; another had eaten a female, evidently caught on her nest, and half a dozen of her eggs; a third had taken four bobwhites and a scaled partridge."[a] In Mecklenburg County, Va., the

[a] Life Hist. N. Am. Birds [1], p. 8, 1892.

king snake (*Lampropeltis getula*) has been known to eat a clutch of eggs. At Falls Church, Va., Harvey Riley captured a black snake (*Bascanion constrictor*) which disgorged a newly hatched bobwhite. Reference has been made already to the marked decrease in the number of bobwhites on the 230-acre farm at Marshall Hall, from fifty-odd birds in July to less than a dozen in December, though not more than a dozen had been shot. This decrease was probably due, at least in part, to gray foxes; for in August and September these animals were numerous, and often came after the chickens within a stone's throw of the farmhouse. Other predaceous mammals and birds of prey were not numerous, but foxes frequently were seen at midday searching through pastures where there were broods of bobwhites. It must be easy for a fox to exterminate a whole brood of newly hatched bobwhites, and no difficult task to catch them even when three-fourths grown. Minks and weasels, when numerous, are probably even more destructive to young bobwhites than to domestic poultry. The domestic cat that takes to foraging in woods and fields is also a menace and should be shot on suspicion, for it undoubtedly preys on game birds, as it is known to do on song birds and young rabbits.

In Maryland and Virginia the writer has found the crow plundering nests of the bobwhite, and in these States the crow is an enemy also of poultry. Doctor Fisher states in his Hawks and Owls of the United States that of the forty-odd species which he studied he found only nine that killed the bobwhite. Four of these—the goshawk, Cooper hawk, sharp-shinned hawk, and great-horned owl—are very destructive to poultry as well as game. Dr. W. C. Strode, of Bernadotte, Ill., writes that bobwhite's worst enemy is the Cooper hawk. "A few days ago one flew up from the roadside when I was passing, and a bobwhite was dangling from one foot." During November, 1900, this species so persecuted the birds at Marshall Hall that they were seldom found far from cover. In one instance a hawk was seen to swoop to the ground and rise with a cock bobwhite. The other species of hawks and owls rarely molest quail.

If bobwhites more frequently nested along fence rows instead of in open mowing land, they would abound in many places where they are rare. The mowing machine lays many nests bare, and they are either despoiled by enemies or deserted by the old birds. At Sandy Spring, Md., early in July, 1903, four nests with their eggs were cut over in a 50-acre grass lot. In other hay fields several nests were discovered in time to leave grass uncut about them, but boys robbed them all. Between such lads and the crows and other enemies bobwhites have a hard time in certain sections.

To enable them to withstand the winter, bobwhites need suitable

food and cover. In severe winters coveys are sometimes saved by being trapped and fed in confinement until spring. Naturally the birds suffer most in the northern part of their range, but there are reports of their death from severe and protracted cold in Maryland and Virginia. Sandys says: "The birds know when the snow is coming, and they creep under the brush, intending to remain there until the weather has cleared. * * * Then the rain comes and wets the surface all about, then the sleet stiffens it, * * * the cold becomes intense, and every foot of damp snow promptly hardens into solid ice. * * * The quail are now imprisoned beneath a dome of crystal, which may endure for days."[a] H. C. Oberholser says that in severe winters in Wayne County, Ohio, whole coveys are found dead from this cause. Dr. P. L. Hatch reports that in Minnesota the birds increase in numbers during years with mild winters and decrease when the winter is exceptionally severe.[b] Wilson Flagg states in Birds and Seasons of New England that thousands of bobwhites were destroyed by the deep snows of 1856–57. During the very severe winter of 1903–4 bobwhites were nearly exterminated in portions of Massachusetts. That quail do not always succumb to exceptional cold appears from the fact that in Susquehanna County, Pa., at an altitude of 2,000 feet, W. W. Cooke found a covey of a dozen bobwhites apparently in the best of condition on December 9, 1902, though a foot of snow covered the ground and the thermometer stood at 20° below zero.

A study of the winter habits of the bobwhite by the writer in the vicinity of Washington, D. C., so far has yielded only fragmentary results. In February, 1900, after a foot of snow had fallen, in a careful two days' search he failed to discover even a track of a large covey that usually frequented river flats along the Potomac at Marshall Hall. The birds must have been under the snow or back in the timber. At Falls Church, Va., after a lighter fall of snow he saw a covey of five moving among briers on the edge of a wood, and their fresh tracks showed that they had been feeding systematically on rose hips, but had not ventured from cover. At Cabin John Bridge, Md., after a snowfall of several inches his dog pointed six birds on the south side of a river bluff, where the sun had melted holes in the snow. On one of these bare spots he saw two birds, which rose and were joined by four others. The covey had made wallows 2 inches deep in the leaf mold on the bare spots. All the birds had avoided stepping on the snow. At hand was such food as the berries of sumac and the seeds of *Galactia volubilis* and *Chamæchrista fascicularis*. Examination of the droppings indicated that less than

[a] Upland Game Birds, p. 70, 1902.

[b] Notes on the Birds of Minnesota, p. 155, 1892.

one-tenth of the food had been animal matter, the remains of which consisted of ants, the tibiæ of grasshoppers, the spotted cuticle of soldier bugs, and the cow-horn-like mandibles of spiders. So far as could be made out, the remains of vegetable food consisted of the skin of kernels of corn, fragments of the akenes of ragweed, and pulverized bits of sumac seeds (*Rhus copallina*), partridge pea (*Chamæchrista fasciculuris*), milk pea (*Galactia volubilis*), and crownbeard (*Verbesina*), besides unidentified leaf material. The weather had been severe for more than a week, but the birds were in good condition.

On the Marshall Hall farm, a short distance back from the banks of the Potomac, is a swamp that has a steep bank with a southern exposure where there is usually more or less bare ground in patches. For several years bobwhites have made a winter haunt of this warm, sunny bank, and here some interesting observations were made February 18 and 19, 1902, when the snow was from 2 to 4 inches deep and the minimum temperature was 4° F. above zero. A covey had spent the night of February 17 not on the warm bank, comparatively bare of snow, but on the level above the bank, where they had squatted on the snow under a dewberry bush among broomsedge. Their feet and droppings had melted the snow, and subsequent freezing had formed an icy ring. The birds had not flown thither, but had walked from the swamp up the steep bank and through the broomsedge level. The next morning they had flown from the roost to the steep slope, had run along the edge of the swamp to a bushy, tree-bordered stream, then up its north bank for 300 yards and back on the south bank, and thence to the steep, sunny slope again. On their journey they had gone under every matted tangle of cat-brier vines—possibly for berries, but more probably for protection. At one point they had fed freely on sumac berries. The tracks of a fox were found with those of the birds for about 100 yards. On the morning of the 19th they traveled not more than 200 yards, this chiefly among outstanding willows and alders of the swamp and along the belt of land 5 to 20 yards wide between the boundary fence and the reeds of the swamp. In one place two pairs of birds had walked so near together as to cross one another's tracks; two single birds had made clear lines of tracks on one side of them, and a single bird had walked alone on the other side from 1 to 4 feet from his nearest companion. All had evidently eaten rose hips, mutilated remains of which still clung to the bushes. The covey might have been expected to range far and wide in the open fields for seeds and even to straw ricks for grain, but except when traveling to their roost they had never gone more than a rod from cover. Apparently fear of enemies restrained them.

An article in the American Field, February 25, 1899, by the well-known sportsman John Bolus, of Wooster, Ohio, illustrates the hardi-

ness of the bobwhite. When several inches of snow were on the ground and the thermometer registered from 15 to 27 degrees below zero every night for a week, Mr. Bolus took a tramp to see how the birds had fared. He found no dead birds, but saw six thrifty coveys—81 birds in all. They were feeding on ragweed projecting from the snow, and were jumping up to reach seeds on sprays above their heads. Some coveys remained under shelter of little weed patches, but others ranged over the more open fields.

In Maryland and Virginia large landowners often feed their birds in severe weather. Wheat and corn are the best food, and should be scattered, if possible, among the briers where the birds are safe from hawks. Bobwhites have been known to feed with chickens in barnyards. By a little forethought landowners and sportsmen can easily make winter provision for their birds. Sumac bushes should be left along hedgerows and the edge of woodland to furnish food that is always above the snow and lasts well into spring. Twelve bobwhites collected in December in North Dakota had made nine-tenths of their food of sumac, having eaten from 50 to 300 berries each. A similar use, in coast regions, of the bayberry and wax myrtle has been noted. Their berries, as well as those of sumac, last till May, and the plants should always be spared by everyone who is interested in the welfare of the bobwhite. Smilax, affording little food but fine cover, and wild roses, giving both food and cover, are also valuable. Blackberry thickets, young pine woods, laurel, and holly furnish safe retreats from enemies.

The farmer can well afford to feed the bobwhite in winter, but he can not afford to spend as much time and money as the owner of game preserves, and for the latter class further suggestions may be helpful. In the Eastern and Southern States land that will not grow profitable crops may be used for the game preserve, provided it has water and bushy coverts. The use of the mowing machine, so destructive to eggs and young birds, should be avoided when possible during the breeding season. Wheat for the birds should be sown in long strips not over 50 yards wide. The best of the grain may be harvested and the rest left standing. On the stubble a luxuriant growth of ragweed will generally spring up—a perfect food supply, except that it does not last till spring; hence the need of sumac or bayberry. In regions too dry for ragweed to grow in the stubble, sunflowers are an excellent substitute. Sorghum, millet (*Chætochloa*), and possibly panicum may be planted and left standing. Pop corn will be found particularly valuable, as large corn can not easily be swallowed by the younger birds. Buckwheat, and in the South the nutritious cowpea, and the climbing false buckwheat, the thick tangles of which also afford good cover, bear excellent food. Other plants of the genus

Polygonum are fond of moist land, and furnish palatable seeds for the bobwhite; for instance, black bindweed (*Polygonum convolvulus*), *Pennsylvania persicaria* (*Persicaria pennsylvanicum*), and black heart (*Persicaria lapathifolia*). All wild leguminous plants should be left undisturbed, for the birds feed on seeds of most of our legumes. Small clumps of locusts may well be left in open fields to give both food and cover. Tick trefoil, bush clover, Japan clover, the milkpea, and the wild bean—all wild plants—are suitable for food. Of the summer fruits the dewberry is the most important, and in the absence of water furnishes a substitute; therefore these vines, nearly everywhere plentiful, should be left in places remote from water. A water supply is of course important. Streams with bush-grown banks through open fields are most valuable. Beside them will be found spreading panicum (*Panicum proliferum*), which shells out its grain a kernel or two at a time until well into spring. Birds find food, shade, water, and shelter in the vegetation along small streams. Marshes also afford cover and food. If connected with estuaries they often support a rank growth of wild rice, an ideal provision for birds. Sufficient shelter to protect the birds from hawks is almost indispensable. Oak and beech woods supply mast as well as shelter, but pines afford the best cover, and some of them, notably the longleaf pine, furnish food. A comfortable retreat for the coldest weather is invaluable. In Maryland and Virginia fields of heavy broomsedge answer this purpose well, but best of all is a steep bank with southern exposure, where the sun quickly melts the snow, and gives the birds a chance to forage on bare spots for food and gravel. If such a bank is not far from cover, and has a growth of briers on it to give the birds a feeling of security, it will become a favorite winter haunt and during severe weather is the best place to scatter grain. With a little help from man the bobwhite will be found to winter well even in the northern part of its range.

Bobwhite is prolific. A pair of birds under favorable conditions will raise a dozen young in a season. Then, too, it is long lived, for a bird kept in captivity is known to have reached the age of 9 years.[a] The outlook for the future of the species is most satisfactory, provided it is given even a small amount of care, with proper legal protection. The Audubon societies, with a membership of 65,000 to 70,000, which cherish the bobwhite for esthetic and humanitarian reasons, the sportsman who loves the whirr of its brown wings, and the farmer, whose enemies it destroys and whose resources it increases, can do much to favor the bird in its natural environment and to protect it by adequate and effectively enforced laws.

[a] Forest and Stream, VII, p. 407, 1876.

FOOD HABITS OF BOBWHITE.

Both field and laboratory investigations of the food habits of the bobwhite have been conducted by the Biological Survey. The field work was confined chiefly to Maryland and Virginia, and, although it represents in some degree every month in the year, has been limited mainly to the breeding and the hunting seasons. The laboratory work to determine the different kinds of food and their proportions has included examination of the contents of crops and gizzards from 918 birds. This material was collected from 21 States, Canada, the District of Columbia, and Mexico, but chiefly from New York, Maryland, Virginia, Florida, Illinois, South Dakota, Nebraska, Kansas, and Texas. Stomachs were obtained each month of the year, but unfortunately few were collected in the breeding season. Laboratory work included also feeding experiments with three pairs of captive bobwhites obtained from Kansas.

The bird's digestive organs are well adapted to the character of its diet. The stomach, or gizzard, as it is commonly called, is provided with powerful muscles for grinding the hard seeds on which the bird largely subsists. The crop, a sac like enlargement of the œsophagus, is a mere membranous receptacle for first receiving the food, and is without muscles. Its capacity is usually from four to six times that of the stomach.

The bobwhite is insectivorous as well as graminivorous. It is, in fact, one of our most nearly omnivorous species. In addition to seeds, fruit, leaves, buds, tubers, and insects, it has been known to eat spiders, myriapods, crustaceans, mollusks, and even batrachians. The food for the year as a whole, calculated by volume and determined by analysis of the contents of 918 stomachs, consisted of vegetable matter, 83.59 per cent, and animal matter, 16.41 per cent. In addition, there was mineral matter varying in amount from 1 to 5 per cent of the gross contents of the stomachs, and in exceptional cases rising to 30 per cent. This usually consisted of sand, with coarser bits of quartz 2 to 7 mm. in diameter, which were taken to pulverize the food and thus render it easier of assimilation.

The vegetable part of the food consisted of grain, 17.38 per cent; various seeds, chiefly weeds, 52.83 per cent; fruit, 9.57 per cent, and miscellaneous vegetable matter, 3.81 per cent. The animal matter in the food was distributed as follows: Beetles, 6.92 per cent; grasshoppers, 3.71 per cent; bugs, 2.77 per cent; caterpillars, 0.95 per cent; miscellaneous insects, 0.70 per cent; and other invertebrates, largely spiders, 1.36 per cent.

The insect food of bobwhite, in comparison with that of other birds, is interesting. It includes fewer caterpillars, ants, and other Hymenoptera, but more bugs; and, singularly enough in a terrestrial

feeder, nearly twice as large a proportion of beetles as of grasshoppers. The meadow lark, per contra, another terrestrial feeder, takes 29 per cent of grasshoppers and only 18 per cent of beetles.

The food of the bobwhite for the year is noteworthy in several respects. Its character varies with the season. From October to March it consists almost exclusively of vegetable matter—for February and March 99.8 per cent of vegetable food appearing in analysis—while in late spring and in summer it is made up largely of insects, August showing 44.1 per cent of insect food. The grain taken, as a rule, is derived neither from newly sown fields nor from standing crops, but is gleaned from stubble fields after harvest. Grain forms a less prominent part of the food than the seeds of weeds, which are the most important element of all and make up one-half of the food for the year. The most distinctive feature of this, as a whole, is the large proportion—15.52 per cent—of leguminous seeds, a food seldom eaten by the various species of sparrows or other terrestrial feeders. A small fraction of this seed comes from cultivated plants, especially the cowpea; the rest is derived from wild plants, most of them classed as weeds. Leguminous seeds appear to be most largely consumed during December, when they form 25 per cent of the food. The 15.05 per cent of insect food, although a comparatively small part of the total, is of extreme importance, since it contains many pests that are generally avoided by nongallinaceous birds. Noteworthy among these are the potato beetle, twelve-spotted cucumber beetle, striped cucumber beetle, squash ladybird beetle, various cutworms, the tobacco worm, army worm, cotton worm, cotton bollworm, the clover weevil, cotton boll weevil, imbricated snout beetle, May beetle, click beetle, the red-legged grasshopper, Rocky Mountain locust, and chinch bug.

It should be observed that in the search for these pests and for weed seeds the bobwhite, unlike many birds of the woodland, hedgerow, and orchard, extends its foraging to the center of the largest fields, thus protecting the growing crops.

Grain as Food.

Vegetable matter has long been known to be an important element of the food of the bobwhite; indeed, many people suppose that it constitutes the entire food of the bird. The impression that the bobwhite eats little else than grain has prevailed even among many sportsmen who have bagged most of their game in the stubble field. The present analysis, however, discloses that grain forms scarcely more than one-sixth of the food. Laboratory study shows that it is eaten in every month of the year, the maximum amount, 46 per cent of the food for the month, having been taken in March. In the

specimens examined corn amounts to 11.96 per cent of the total food for the year, while all other kinds of grain collectively amount to only 5.42 per cent. Wheat (4.17 per cent) is next to corn in importance. As experiments with captive birds failed to show marked preference for either corn or wheat, the disproportion between the two above noted is probably due to the fact that more corn than wheat is grown in the country where our birds were obtained. The remaining cereal food (1.25 per cent of the total) is miscellaneous grain, including Kafir corn, sorghum, millet, buckwheat, barley, oats, and rye.

Grain-eating birds are likely to do much harm to crops. They may pull up sprouting grain, plunder the standing crop when it is in the milk, or forage among the sheaves at harvest time. The bobwhite, however, is a notable exception. The period of germination is the time when grain is liable to serious injury by birds. But not a single sprouting kernel was found in the crops and stomachs of quails examined. Field observations, during the years 1899 and 1900, at Marshall Hall gave similar evidence. While crows injured sprouting corn so seriously during May that several extensive replantings were necessary, bobwhites, unusually abundant in the vicinity at the same time, were never seen to disturb the germinating grain. During November, 1899, sprouting wheat was saved from crow blackbirds only by diligent use of the shotgun; but both then and in other seasons the bobwhite was rarely observed in winter-wheat fields and never was seen to molest the crop. Sprouting oats apparently were not molested, though extended observations were not made. No data are available for rye and millet, but in newly sown buckwheat fields in Essex County, N. J., which the writer saw ravaged by doves, there was no sign of injury by the bobwhites. Publications on economic ornithology and reports received by the Biological Survey add testimony of like character. It may safely be stated, therefore, that so far as at present known the bobwhite does no appreciable harm to sprouting grain.

In order to learn to what extent the species injures ripening grain, observations were made for several years at Marshall Hall. Unlike the crow and several kinds of blackbirds, the bobwhite did no damage there to corn in the milk, nor did it injure ripening wheat and oats. Flocks of English sparrows, however, might be seen feeding on wheat in the milk, and not uncommonly a score of goldfinches swayed on the panicles of ripening oats. A hen bobwhite shot in a field of ripe wheat, June 18, 1903, had much of the grain in its crop, though whether obtained from standing heads or from fallen kernels did not appear. As the bobwhite usually feeds on the ground, and as it was never seen feeding from the stalk at Marshall Hall, it appears probable that it seeks only the fallen grain. At wheat harvest it follows

the binder, and at Marshall Hall was often seen in the harvest field picking up scattered wheat. It was not observed there on the shocks, appearing to find an abundance of waste kernels. At corn harvest also bobwhite takes its share from exposed ears; but the bird is not able to shuck corn, as do the crow and the wild goose. Several crops of ripe oats at Marshall Hall were watched during harvest time and furnished no evidence against the bobwhite. No report of injury by it elsewhere at harvest time has come to the Biological Survey, though damage may be done where peculiar local conditions conjoin with an overabundance of birds.

The bobwhite, however, is a persistent stubble feeder. As Mr. Sandys puts it, "He is the gleaner who never reaps, who guards the growing crops, who glories over a bounteous yield, yet is content to watch and wait for those lost grains which fall to him by right." Where fields of wheat stubble support a rank growth of ragweed the sportsman is most likely to find a feeding covey. At Marshall Hall, during September, October, and November, such fields are the favorite haunts of the birds. On this farm corn has a greater acreage than wheat, but the birds are much less often found in corn stubble; and, as stomach examinations show, they eat much less corn than wheat. Since experiments with captive birds showed no preference for wheat, food other than grain may have kept them on the wheat stubble. Along the Roanoke in Virginia, where wheat is not grown, bobwhites feed in corn fields.

On the Western prairies, where cornstalks left standing in the fields afford good cover, the birds are more often found in cornfields. Six birds collected from such fields in November, 1891, at Badger, Nebr., contained 181 whole kernels of corn; the smallest number in a crop was 20 and the largest 48.

It is not unusual to find from 100 to 200 grains of wheat in a crop. A bobwhite shot at West Appomattox, Va., in December, 1902, had its crop distended almost to bursting with 508 grains of wheat. This habit of gleaning waste grain after harvest is beneficial to the farm, for volunteer grain is not desirable, especially where certain insect pests or parasitic fungi are to be combated. As the scattered kernels are often too far afield to be gathered by domestic poultry, the services of the bobwhite in this respect are especially useful.

The bobwhite sometimes eats the seeds of certain cultivated leguminous plants. Both the black-eye and the clay cowpeas (*Vigna sinensis*) have been found in stomachs, and one contained 35 peas of the latter variety. In Westmoreland and Mecklenburg counties, Va., cowpea patches are favorite resorts for the birds in November and December. Garden peas were found in crops collected by Mr. Walter Hoxie at Frogmore, S. C. In rare instances the bobwhite picks up clover

seeds, and it has been known to eat a lima bean. It may take also Kafir corn and sorghum, and it has a decided liking for millet (*Chætochloa italica*), a taste particularly noticeable in birds of Kansas, Nebraska, and South Dakota. A crop from Onaga, Kans., contained 1,000 millet seeds. No significant damage to millet has been reported and the birds may secure most of this food from stubble fields.

Weed Seeds as Food.

Weeds appropriate the space, light, water, and food of the plants that directly or indirectly support man. A million weeds may spring up on a single acre, and a single plant of one of these species may mature 100,000 seeds in a season. This process, if unchecked, may produce in the spring of the third year 10,000,000,000 weeds. The problem of weed destruction is perennial in every land; indeed, soil culture may be called a never ceasing war against weeds. Of the birds that aid the farmer in this struggle the bobwhite, the native sparrows, and the mourning dove are the most efficient. They attack weeds at that vital stage—the seed period—hence their work, especially against the annuals which depend on seeds for perpetuation, is of enormous practical value.

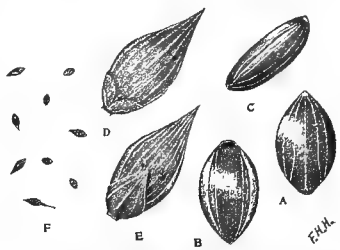


Fig. 1.—Seed of witch grass (*Panicum capillare*). (From Bull. 38, Nevada Agricultural Experiment Station.)

The bobwhite is preeminently a seed eater, 52.83 per cent of its food for the year consisting of seeds. The bulk of these are the seeds of plants belonging to the general category of weeds. Many of them are injurious plants with which the farmer is constantly at strife; others are less noxious and some are seldom, if ever, troublesome. Sixty-odd species are known to be eaten, and thorough observations would probably raise the number to a hundred or more. The food of no other bird with which the writer is acquainted is so varied. At Marshall Hall and in Mecklenburg and Westmoreland counties, Va., a somewhat detailed study was made of the weed seed eaten by the bird. At Marshall Hall fields of wheat stubble grown up to ragweed were favorite feeding grounds. Among others found there were buttonweed seeds, each like a miniature horsehoof, complete even to the frog; 20 or 30 of these were sometimes contained in a single stomach. A number of birds shot on wheat stubble had eaten largely of bastard pennyroyal seeds, which are rough and resemble blackberry seeds. Goldfinches and other seed eaters also find these palatable. Along ditches the abundant grasses—witch grass (fig. 1) and spreading panicum—provide the birds with shade in summer and

eaten at a meal may suggest the value of the bird as a weed destroyer. As many as 200 to 300 smartweed seeds, 500 seeds of red sorrel, and 700 seeds of three-seeded mercury have been taken at a meal. Crops and stomachs crammed with nothing but ragweed seeds are often found. A bird shot November 6, 1902, at Marshall Hall, had eaten 1,000 ragweed akenes; another killed there the previous November had eaten as many seeds of crab grass. Birds shot in Mecklenburg County, Va., contained about 2,000 leguminous seeds, mainly tick-trefoil, and various kinds of bush clover. A bird shot in October, 1902, at Pine Brook, N. J., had eaten 5,000 seeds of green foxtail grass, and one killed on Christmas day, 1901, at Kinsale, Va., had taken about 10,000 pigweed seeds.

LIST OF WEED SEEDS EATEN.

The list of seeds eaten, excluding mast and pine seeds, is as follows:

Slender paspalum (*Paspalum setaceum*).
Slender finger grass (*Syntherisma filiformis*).
Crab grass (*Syntherisma sanguinalis*).
Barnyard grass (*Echinochloa crus-galli*).
Barbed panicum (*Panicum barbulatum*).
Switch grass, tall smooth panicum (*Panicum virgatum*).
Spreading panicum (*Panicum proliferum*).
Witch grass (*Panicum capillare*).
Yellow foxtail (*Chætochloa glauca*).
Green foxtail (*Chætochloa viridis*).
Timothy (*Phleum pratense*).
Sheathed rush grass (*Sporobolus vaginæflorus*).
Slender spike grass (*Uniola laxa*).
Wild rice (*Zizania aquatica*).
Nut grass (*Cyperus rotundus*).
Rush (*Scirpus?*).
Sedge (*Carex* sp.).
Tussock sedge (*Carex stricta*).
Skunk cabbage (*Spathyema fœtida*).
Red sorrel (*Rumex acetosella*).
Curled dock (*Rumex crispus*).
Pale persicaria (*Persicaria lopathifolia*).
Pennsylvania persicaria (*Persicaria pennsylvanica*).
Smartweed (*Persicaria hydropiper*).
Knotweed (*Polygonum aviculare*).
Black bindweed (*Polygonum convolvulus*).
Climbing false buckwheat (*Tiniaria scandens*).
Lamb's-quarters (*Chenopodium album*).
Rough pigweed (*Amaranthus retroflexus*).
Carpet weed (*Mollugo verticillata*).
Corn cockle (*Agrostemma githago*).
Chickweed (*Alsine media*).
Charlock (*Raphanus raphanistrum*).
Witch hazel (*Hamamelis virginiana*).
Acacia (*Acacia* sp.).
Redbud (*Cercis canadensis*).
Sensitive pea (*Chamæcrista nictitans*).
Partridge pea (*Chamæcrista fasciculatis*).
Cassia (*Cassia* sp.).
Lupine (*Lupinus* sp.).
Clover (*Trifolium* sp.).
Trefoil (*Lotus* sp.).
Psoralea (*Psoralea* sp.).
Locust (*Robinia pseudacacia*).
Florida coffee (*Sesban macrocarpa*).
Tick-trefoil (*Meibomia nudiflora* and *M. grandiflora*).
Hairy bush clover (*Lespedeza hirta*).
Creeping bush clover (*Lespedeza repens*).
Bush clover (*Lespedeza violacea*).
Japan clover (*Lespedeza striata*).
Vetch (*Vicia* sp.).
Hog peanut (*Falcata comosa*).

Downy milkpea (*Galactia volubilis*).
Prairie rhynchosia (*Dolicholus latifolius*).
Trailing wild bean (*Strophostyles helvcola*).
Pink wild bean (*Strophostyles umbellata*).
Crane's bill (*Geranium carolinianum*).
Yellow sorrel (*Oxalis stricta*).
Croton (*Croton* sp.).
Texas croton (*Croton texensis*).
Three-seeded mercury (*Acalypha gracilens*).
Spotted spurge (*Euphorbia maculata*).
Flowering spurge (*Euphorbia corollata*).
Red maple (*Acer rubrum*).
Box elder (*Rulac negundo*).
Jewel weed (*Impatiens* sp.).
Sida (*Sida spinosa*).
Violet (*Viola* sp.).
Ash (*Fraxinus* sp.).
Morning glory (*Ipomœa* sp.).
Bindweed (*Convolvulus* sp.).
Corn gromwell (*Lithospermum arvense*).
Hoary puccoon (*Lithospermum canescens*).
Gromwell (*Lithospermum officinale*).
Vervain (*Verbena stricta*).
Bastard pennyroyal (*Trichostema dichotomum*).
Ribgrass (*Plantago lanceolata*).
Button weed (*Diodia teres*).
Trumpet creeper (*Campsis radicans*).
Orange hawkweed (*Hieracium aurantiacum*).
Marsh elder (*Iva ciliata*).
Giant ragweed (*Ambrosia trifida*).
Ragweed (*Ambrosia artemisiæfolia*).
Everlasting (*Antennaria* sp.).
Sunflower (*Helianthus* sp.).
Common sunflower (*Helianthus annuus*).
Crownbeard (*Verbesina* sp.).
Beggar ticks (*Bidens* sp.).

Mast and Pine Seeds as Food.

Mast, including acorns of the swamp oak (*Quercus palustris*), the white oak (*Q. alba*), beechnuts, the blue beech (*Carpinus caroliniana*), and the chestnut, amounts to 2.47 per cent of the food of the year.

In the pine lands of Florida the bobwhite freely eats the seeds of the long-leaf pine (*Pinus palustris*). Of the 39 birds from Walton County (November, December, and January, 1902 and 1903), 21 had their crops and stomachs mainly filled with this nutritious food. They had usually clipped off the wings of the samaras close to the large seeds. Several crops were full of germinating pine seeds, some of the embryos having cotyledons 2 inches long. In the region about Washington the seeds of the scrub pine (*Pinus virginiana*) also are eaten to a small extent. The fact that these seeds are a good winter food should be remembered by holders of game preserves. Observations show that the key seeds of the maple also are eaten, though much less extensively.

Fruit as Food.

Unlike the catbird and the cedarbird, whose food consists, respectively, of 50 and 87 per cent of fruit, the food of bobwhite for the year includes only 9.57 per cent of fruit. It is least frugivorous in spring and most so in June and in December and January, taking 20.1 per cent in the summer month and a little over 18 per cent during the two winter months. If more birds collected in June had been

available for examination, probably the percentage of fruit would have been lower. The December percentage is evidently characteristic, for it was based on the examination of about 200 stomachs.

In early spring wild winter-cured berries, in May strawberries, later the *Rubus* fruits—thimbleberry, dewberry, and highbush blackberry—and in late summer and autumn an endless profusion of the year's wild harvest yield the bobwhite an accessible and abundant food supply. In late fall and winter, when snow covers the seeds, fruit doubtless keeps it from starving. In December it forms nearly one-fifth of the food for the month. Sumac, wax-myrtle, rose, and bayberry are the main winter supply. Poison-ivy berries are eaten occasionally. Rose hips often project from the snow and furnish timely food. At Falls Church, Va., and at Cabin John Bridge and Marshall Hall, Md., tracks of coveys in deep snow led up to rose shoots to which partly eaten hips were clinging. Sumac and other plants of the genus *Rhus* form 1.60 per cent of the annual food, and during December the proportion of *Rhus* alone is 10.50 per cent. Of 12 birds shot during December at Porters Landing, S. Dak., near the bobwhite's northern limit, by W. C. Colt, each had eaten from 100 to 300 of the carmine sumac berries, and altogether the sumac had furnished 90 per cent of the food they contained. Bayberry and wax-myrtle are as important along the coast as sumacs are inland. Berries of wax-myrtle were found in the stomachs of 15 out of 39 birds collected during November, December, and January, 1902 and 1903, in Walton County, Fla. One hundred and twenty bayberries had been eaten by one bird taken in July, 1901, at Shelter Island, N. Y. Both these fruits last through the winter and well into May, affording excellent provision just when it is most needed.

In spite of its frugivorous tastes and constant association with orchard crops, the bobwhite is not often known to injure cultivated fruits. M. B. Waite reports that near Odenton, Md., it sometimes picks ripening strawberries. Yet birds that were kept in captivity several months refused strawberries when they were hungry. Cultivated cherries were found in a few stomachs, but the bobwhite is not an arboreal feeder and does not damage this crop. During June at Marshall Hall it was repeatedly observed feeding greedily upon the fruit of running dewberry vines. It probably does no serious harm, however, to cultivated bush varieties of *Rubus*, such as the thimbleberry, the raspberry, and the blackberry. It is fond of wild grapes, and a number of crops each contained as many as 25 frost grapes (*Vitis cordifolia*). Hence it might be expected to injure cultivated varieties, for its relative, the California quail, sometimes plunders vineyards; but, so far as the writer knows, vineyards in the East have sustained no appreciable damage from the bobwhite.

In summing up the frugivorous habits of the bobwhite, it may be

said that the present investigation shows no appreciable injury to cultivated fruit, but a marked liking for wild fruit. It may be interesting to note, also, that the bobwhite is not nearly so frugivorous as the ruffed grouse.

LIST OF FRUITS EATEN.

Although the percentage of wild fruits yearly consumed is comparatively small, the variety is great, as shown by the appended list, which includes only those actually ascertained to have been eaten. A few careful observers could easily double the number.

Cabbage palmetto (*Inodes palmetto*).
Saw palmetto (*Serenoa serrulata*).
Solomon's seal (*Polygonatum*).
Greenbrier (*Smilax* sp.).
Wax myrtle (*Myrica cerifera*).
Bayberry (*Myrica carolinensis*).
Mulberry (*Morus rubra*).
Sassafras (*Sassafras sassafras*).
Thimbleberry (*Rubus occidentalis*).
High bush blackberry (*Rubus nigrobaccus*).
Dewberry (*Rubus procumbens*).
Strawberry (*Fragaria* sp.).
Rose (*Rosa*).
Haw (*Crataegus* sp.).
Apple (*Malus malus*).
Cultivated cherry (*Prunus* sp.).
Wild cherry (*Prunus serotina*).
Poison ivy (*Rhus radicans*).
Dwarf sumac (*Rhus copallina*).
Staghorn sumac (*Rhus hirta*).
Smooth scarlet sumac (*Rhus glabra*).
Holly (*Ilex opaca*).
Black alder (*Ilex verticillata*).
Climbing bittersweet (*Celastrus scandens*).
Frost grape (*Vitis cordifolia*).
Flowering dogwood (*Cornus florida*).
Sour gum (*Nyssa sylvatica*).
Wintergreen (*Gaultheria procumbens*).
Huckleberry (*Gaylussacia* sp.).
Blueberry (*Vaccinium* sp.).
Ground-cherry (*Physalis pubescens*).
Nightshade (*Solanum nigrum*).
Elder (*Sambucus canadensis*).
Black haw (*Viburnum prunifolium*).
Honeysuckle (*Lonicera* sp.).
Partridge berry (*Mitchella repens*).
Sarsaparilla (*Aralia*).
Woodbine (*Parthenocissus quinquefolia*).

LEAVES AND BUDS AS FOOD.

The bobwhite does not approach the ruffed grouse in destructiveness to leaves, buds, and tender shoots, though occasionally it samples them. It eats the leaves of sorrel sometimes, both yellow sorrel (*Oxalis stricta*) and red sorrel (*Rumex acetosella*). It has been known to take the leaves of cinquefoil (*Potentilla*), and is extremely fond of both red and white clover. Captive birds ate grass, lettuce, and chickweed.

INSECTS AS FOOD.

Notwithstanding statements to the contrary, published and unpublished, the bobwhite eats insects in every month of the year. They form 15.05 per cent of its entire food for the year. From June to August, inclusive, when insects are most numerous, their proportion in the food is 35.97 per cent. The variety of insect food is large.

In the present investigation 116 species have been noted, and further study will doubtless greatly increase the number. Moreover, the large proportion of injurious insects habitually eaten renders the services of this bird more valuable than those of many birds whose percentage of insect food, though greater, includes a smaller proportion of injurious species. Conspicuous among the pests destroyed are the Colorado potato beetle, twelve-spotted cucumber beetle, bean leaf-beetle, squash ladybird, wireworms and their beetle, and May beetles. Its food also includes such weevils as corn billbugs, imbricated snout beetle, clover leaf weevil, cotton boll weevil; also the striped garden caterpillar, army worm, cotton bollworm, and various species of cutworms; also the corn-louse ants, red-legged grasshopper, Rocky Mountain locust, and chinch bug. The bobwhite does not merely sample these species, as do many other birds; it eats some of them in considerable numbers, for crops examined have contained, respectively, a dozen cutworms, an equal number of army worms, 30 Rocky Mountain locusts, and 47 cotton boll weevils. This bird also destroys striped cucumber beetles by the score, potato beetles by the hundred, and chinch bugs in great numbers. From June to August, inclusive, insects and their allies form, as previously mentioned, about a third of the food. Of this beetles make up nearly half, or 15.37 per cent; bugs, 8.54 per cent; caterpillars, 1.37 per cent; grasshoppers, 6.93 per cent; miscellaneous insects, 1.33 per cent, and spiders, with other invertebrates, 2.43 per cent.

BEETLES EATEN.

The beetles most largely destroyed are ground beetles, leaf-eating beetles, and weevils. Naturally, because of the terrestrial habits of the bobwhite, ground beetles, in spite of their vile odor and irritating secretions, are picked up oftener than the other kinds. Experiments with caged birds prove that even the most pungent forms are relished. Ground beetles are numerous in species and superabundant in individuals. One can form no adequate idea of their numbers except at night. Arc lights kill them by thousands. The writer has known one species (*Harpalus pennsylvanicus*) to enter open windows in the evening in swarms. They have an irritating secretion, which if applied to the skin soon raises a blister. Ground beetles are more or less predaceous, hence the whole family was formerly considered beneficial. Later study has resulted in their division into three classes: The most carnivorous species, possessing sharp, curved jaws for capturing and killing other insects; the least predaceous forms, having blunt jaws and eating considerable vegetable matter; and a class intermediate between these two. The first class contains highly beneficial beetles which destroy great numbers of insect pests, while the blunt-jawed class includes some injurious species that feed on

crops. Only a few of the bobwhite stomachs examined contained the useful sharp-jawed beetles, but many contained the blunt-jawed species, especially such forms as *Amara* sp., *Agonoderus pallipes*, *Anisodactylus baltimorensis*, *Anisodactylus rusticus*, *Harpalus pennsylvanicus*, and *Harpalus caliginosus*. At Marshall Hall, in August, 1902, a covey of bobwhites was seen greedily eating beetles of the two species of *Harpalus* named above, which were numerous in wheat stubble overgrown by ragweed. The meadow lark, also, was feeding on them. The liking of the bobwhite for *Harpalus pennsylvanicus* was further proved by experiments with caged birds. It eats also the larvæ of these beetles, as do the robin and several other birds. Though the genus *Harpalus* as a whole is useful, destruction of these two species is not amiss, for they injure ripening strawberries by eating out the seeds. Through their depredations on a quarter-acre patch a grower at Leesburg, Va., in three nights lost $350 worth of fruit. The nature of the injury by the beetle has so far made remedial measures impracticable; therefore, the work of the bobwhite and other birds should be estimated at its full value.

Leaf-eating beetles, next in importance after ground beetles in the diet of the bobwhite, include many of the worst beetle pests, and members of the family not already actively injurious are potentially so. These beetles also are provided with protective secretions, more effectively repellant in the larger species, at least, than those of ground beetles, but luckily ineffectual against bobwhite. He eats the most injurious of these insects, such as the potato beetle (*Leptinotarsa decemlineata*), the striped cucumber beetle (*Diabrotica vittata*), the twelve-spotted cucumber beetle (*Diabrotica 12-punctata*), and the squash ladybird (*Epilachna borealis*). The first named is perhaps more correctly termed the Colorado potato beetle. It was a native of the Rocky Mountains originally, feeding on the horse-nettle (*Solanum rostratum*), a plant related to the potato. It began to migrate eastward a year or two before the civil war, and fifteen or sixteen years later reached the Atlantic coast. Since then, as every one knows, this beetle has threatened the potato crop of the country. Birds as a rule avoid it because of its secretions. Therefore the bobwhite's services in destroying it should be highly valued, the more so because the bird's habit of eating the potato bug is not merely occasional nor limited to special localities. Records have come to the Biological Survey from New Jersey, Virginia, Maryland, Iowa, Kansas, Nebraska, Texas, and Ontario; and it is believed that more extended observations will show that the habit is general wherever the birds and the beetles inhabit the same district. During the last week of June, at Marshall Hall, a pair of birds was observed patroling rows of badly infested potato vines and diligently picking off the beetles. Writing of the bird's relation to this insect, C. E.

Romaine, of Crockett, Tex., says: "Quail have built their nests around my fence and even in my garden, within 50 feet of my house. They have kept my potato patch entirely free from the Colorado potato bug." Three captive bobwhites dispatched 50 potato beetles in five minutes, swallowing them whole, apparently with great zest. No food offered them was eaten with more avidity. Thomas McIlwraith says a recent writer mentions that he examined the crop of one which was killed as it rose from a potato patch and found that it contained 75 potato bugs.[a] Lawrence Bruner reports 101 of these beetles found in a single crop.[b] Such wholesale destruction of these pests throughout a large territory is an invaluable aid to agriculture.

The two species of cucumber beetles (*Diabrotica vittata* and *D. 12-punctata*) are highly injurious to cucumbers, squashes, melons, and corn, much of the harm being caused by their larvæ, which feed on the roots of infested crops and are difficult to combat successfully with insecticides. The bobwhite eats them freely without ill effect, though examination seldom reveals them in the stomachs of other birds. Indeed, captive birds of all the other species experimented with have refused them, probably because of their offensive secretions.

To some extent the bobwhite feeds also on certain leaf beetles, known, from their jumping powers, as flea beetles. Its favorites appear to be the three-lined potato beetle (*Lema trilineata*), sometimes an ally of the potato beetle in the potato patch, *Œdionychus fimbriata*, and several members of the genus *Disonycha*. The golden tortoise beetle (*Coptocycla bicolor*), an insect that looks like a drop of molten gold and is an enemy of the sweet potato, is also eaten. The locust leaf-mining beetle (*Odontota dorsalis*) is another victim of the bird. Its larvæ tunnel between the surfaces of locust leaves and kill the foliage. In 1895 the ravages of this pest turned the locust-fringed bluffs on the Potomac below Washington as brown as if touched by fire.

The agriculturist finds weevils hard to cope with, on account of their small size, protective coloration, and retiring mode of life. Birds, however, destroy them in large numbers, often a score or two at a meal, and bobwhite does his share of the work. He often eats two common species that feed on clover leaves (*Sitones hispidulus* and *Phytonomus punctatus*), and preys also on the two billbugs (*Sphenophorus parvulus* and *Sphenophorus zeæ*), the latter injurious to corn. He relishes also that notorious garden pest, the imbricated snout beetle. His most important weevil prey is the Mexican cotton boll weevil (*Anthonomus grandis*). In 1894 this insect first crossed the Mexican border into Texas. During 1903 it caused a loss of

[a] Birds of Ontario, p. 170, 1894. [b] Notes on Nebraska Birds, p. 80, 1896.

$15,000,000. Though still chiefly confined to Texas, in time it will undoubtedly occupy the whole cotton belt and do a tremendous amount of harm. The bobwhite is fond of this pest. F. M. Howard, of Beeville, Tex., in writing to the Bureau of Entomology, says that the crops of bobwhites shot at Beeville, Tex., were filled with these weevils.[a] H. G. Wood, of Cuero, Tex., in a letter dated September 21, 1901, relating to the weevil scourge, says:

> Several of our business men and farmers are of the opinion that the quail can be made a vehicle for the destruction of the cotton boll weevil. One farmer reports his cotton fields full of quail, and the entire absence of weevils. He found 47 weevils in the craw of one bird. * * * I claim quail are the greatest insect destroyers of all birds. * * * We propose to prohibit the killing of quail in this county this season, hoping thereby to save a great portion of the cotton crop next season.

The click beetles, the larvæ of which are the wireworms so inimical to corn and other plants of the grass family; *scarabæid* beetles, though in smaller numbers; dung beetles, when numerous, and May beetles, parents of the injurious white grub, are eaten by the bobwhite. The May beetle (*Lachnosterna* sp.) and its near relative, *Ligyrus gibbosus*, were eagerly eaten by captive birds. The useful ladybirds (*Coccinellidæ*) are sometimes found in the bird's crop, but, judging from experiments with caged birds, do not appear to be highly relished. *Adalia bipunctata* was several times offered and refused, but was finally eaten. The one harmful beetle of the family, the squash ladybird (*Epilachna borealis*), has been found in stomachs and was relished by captive birds. Certain miscellaneous beetles belonging to different families are occasionally picked up, such as rove beetles, soldier beetles, darkling beetles, histerid beetles, and longicorn beetles.

LIST OF BEETLES EATEN.

The beetles known to be eaten by the bobwhite include the following:

GROUND BEETLES (Carabidæ):
- *Scarites subterraneus.*
- *Amara* sp.
- *Casnonia pennsylvanica.*
- *Platynus extensicollis.*
- *Agonoderus pallipes.*
- *Harpalus pennsylvanicus.*
- *Harpalus caliginosus.*
- *Anisodactylus rusticus.*
- *Anisodactylus baltimorensis.*

LEAF BEETLES (Chrysomelidæ):
- *Lema trilineata.*
- *Cryptocephalus venustus.*
- *Colaspis brunnea.*

LEAF BEETLES—Continued.
- *Nodonota tristis.*
- *Leptinotarsa decemlineata* (potato beetle).
- *Chrysomela pulchra.*
- *Chrysomela suturalis.*
- *Cerotoma trifurcata* (bean leaf-beetle).
- *Diabrotica vittata* (striped cucumber beetle).
- *Diabrotica 12-punctata* (twelve-spotted cucumber beetle).
- *Œdionychis fimbriata.*
- *Disonycha 5-vittata.*

[a] Circular 27, new series, Division of Entomology, p. 6, 1897.

LEAF BEETLES—Continued.
Disonycha xanthomelana.
Disonycha crenicollis.
Psylliodes punctulata:
Microrhopala rittata:
Odontota dorsalis (locust leaf-mining beetle).
Coptocycla bicolor (golden tortoise beetle):
MAY BEETLES (Scarabæidæ):
Onthophagus pennsylvanicus (dung beetle).
Aphodius inguinatus (dung beetle).
Serica sp.
Diplotaxis sp. (leaf-chafer).
Lachnosterna tristis (May beetle).
Anomala sp.
Aphonus sp.
SNOUT BEETLES (suborder Rhynchophora):
Thecesternus humeralis.
Epicærus imbricatus (imbricated snout beetle).
Tanymecus confertus.
Aramigus fulleri (Fuller's rose beetle).
Sitones hispidulus (clover weevil).
Phytonomus punctatus (clover-leaf weevil).
SNOUT BEETLES—Continued.
Anthonomus grandis (Mexican cotton boll weevil).
Chalcodermus collaris:
Centrinus sp.
Sphenophorus parvulus (billbug):
Sphenophorus zeæ (corn billbug).
CLICK BEETLES (Elateridæ):
Drasterius elegans:
Agriotes sp.
Melanotus communis:
Corymbites sp.
LADYBIRDS (Coccinellidæ):
Hippodamia parenthesis.
Coccinella sanguinea.
Adalia bipunctata.
Epilachna borealis (squash ladybird).
HISTERID BEETLES (Histeridæ).
DARKLING BEETLES (Tenebrionidæ):
Blapstinus.
ROVE BEETLES (Staphylinidæ).
SOLDIER BEETLES (Lampyridæ):
Chauliognathus pennsylvanicus.
LONGICORN BEETLES (Cerambycidæ):
Tetraopes tetraophthalmus.

BUGS EATEN.

The bobwhite eats comparatively more bugs than most birds, including both *Heteroptera*, or true bugs, and *Homoptera*, which form 2.77 per cent of its food. The maximum number of bugs was taken in August and amounted to 21.1 per cent of the food for that month.

The chinch bug, which in this country has destroyed over $100,000,000 worth of wheat and other cereals in a season, is preyed upon by the bobwhite throughout the year. C. V. Riley says: "In the winter time, when hard pushed for food, this bird must devour immense numbers of the little pests, which winter in just such situations as are frequented by the quail; and this bird should be protected from the gun of the sportsman in every State where the chinch bug is known to run riot."[a] The data possessed by the Biological Survey concerning this species are scanty, but they show that the quail destroys the pest in Ohio, Indiana, Illinois, Missouri, Kansas, and Nebraska. The number of chinch bugs eaten varies, but usually appears to be large. Thus a bird shot October 12, 1901, at Badger, Nebr., by W. C. Colt, had picked up 100, and the American Field for February

[a] Missouri Reports, II, p. 28, 1870.

21, 1903, reports that an observer at Seymour, Ind., found a teaspoonful in a crop. In a letter to the Department of Agriculture, M. A. Page, of Garnett, Kans., says of a bobwhite: "On opening the crop we found about two tablespoonfuls of chinch bugs."

The bobwhite also destroys the false chinch bug (*Nysius angustatus*), which attacks grapes, strawberries, apples, potatoes, turnips, radishes, beets, and cabbages. It eats the tarnished plant bug (*Lygus pratensis*), injurious to fruit and truck crops, and stink bugs of more than a dozen species, one (*Euschistus variolarius*) being a pest on many garden vegetables. The noninjurious species, particularly *Thyanta custator*, are often eaten, one bird containing 30 of them. More *Homoptera* (leaf hoppers and other forms) are eaten by bobwhite than by most other birds. The little leaf hopper (*Oncometopia lateralis*) is especially relished.

LIST OF BUGS EATEN.

HETEROPTERA:
- *Blissus leucopterus* (chinch bug).
- *Nysius angustatus* (false chinch bug).
- *Euschistus tristigmus* (three-spotted soldier bug).
- *Euschistus variolarius.*
- *Euschistus* sp.
- *Podisus* sp.
- *Brochymena* sp.
- *Nezara hilaris.*
- *Mormidea lugens.*
- *Hymenarcys nervosa.*
- *Hymenarcys æqualis.*
- *Thyanta custator.*
- *Œbalus pugnax.*
- *Trichopepla semivittata.*

HETEROPTERA—Continued.
- *Cænus delius.*
- *Peribalus limbolarius.*
- *Lygus pratensis* (tarnished plant bug).
- *Corimelæna* sp.
- *Apiomerus crassipes.*
- *Alydus eurinus.*
- *Corizus* sp.
- *Euthoctha galeator.*
- *Scutelleridæ* (shield-backed bugs).

HOMOPTERA:
- *Oncometopia lateralis.*
- *Oncometopia* sp.
- *Deltocephalus* sp.
- *Diedrocephala* sp.

GRASSHOPPERS AND ALLIED INSECTS EATEN.

Grasshoppers with a few crickets make 3.71 per cent of the yearly food. In September they contribute 11.9 per cent. The walking stick, singularly like a twig and at times very numerous and injurious to foliage of shade and forest trees, has been found in the stomach of the bobwhite. Locusts and meadow grasshoppers, both highly destructive to vegetation, are favorite articles of diet. The bird grasshopper, so called from its size, is occasionally eaten. The destructive grasshoppers or locusts of the genus *Melanoplus*, such as *M. atlanis*, *M. femur-rubrum*, or the red-legged grasshopper, and the Rocky Mountain locust, form the bulk of the orthopterous food of the species. The Rocky Mountain locust is one of the worst of insect pests, and its appearance in large numbers is a calamity. It appears in swarms, clouding the sun and covering the earth, sweeping every

green thing before it, and often driving the farmer from home and threatening him with starvation. During a single season it has caused a loss of $100,000,000.

In 1874–75 Samuel Aughey made a special study of a Nebraska invasion and found that the bobwhites were an active enemy of the locusts. Of 21 birds shot between May and October, inclusive, all but five had fed on locusts. The smallest number taken by any bird was 20 and the largest 39; in all, 539—an average of 25 apiece. C. V. Riley ascertained that the bird feeds also on the eggs of the locust, particularly in winter, when they are exposed by the freezing and thawing of the ground. If every covey destroyed as many locusts in a day as the one just referred to, it is hard to overestimate the usefulness of the bobwhite where abundant in infested regions.

The following are a few of the many species of orthopterous insects identified from the crops and stomachs of bobwhites:

Cricket (*Gryllus* sp.).
Meadow grasshoppers (*Xiphidium, Orchelinum, Scudderia*).
Katydid (*Microcentrum* sp.).
Walking sticks (*Phasmidæ*).
Grouse locust (*Tettix* sp.).
Mountain locust (*Melanoplus spretus*).
Red-legged grasshopper (*Melanoplus femur-rubrum*).
Grasshopper (*Melanoplus bivittatus, M. scudderi, M. atlanis*).
Bird grasshopper (*Schistocerca americana*).

CATERPILLARS EATEN.

The bobwhite seems to eat fewer caterpillars than would be expected from its terrestrial habits. The yearly proportion only formed 0.95 per cent and the maximum quantity eaten in a month was 4 per cent in May. This apparent neglect of caterpillars as food is perhaps due to their scarcity where the birds for the present study were shot. Pupæ and adult moths occasionally serve as food. Whatever the list of species of caterpillars eaten by bobwhite lacks in length it makes up in importance, for so great a proportion of serious lepidopterous pests is seldom found in the fare of any bird. As is true of some other birds, the bobwhite includes the army worm in its bill of fare. This pest sometimes exists in legions and moves steadily forward from field to field, devouring corn, oats, forage, and other crops. Fortunately it is not often active, and the years of its occurrence are frequently separated by long intervals. Every year, however, the different species of cutworms do serious damage. They cut down germinating grain, often before the plants have fairly sprung above ground. Owing to their mode of feeding, a few worms may lop off many plants in a night. It seems strange that the bobwhites find as many of these nocturnal larvæ as they do. The cotton worm, a pest so destructive that in one year it has caused a loss of $30,000,000 to the cotton fields, is preyed upon by the bobwhite. Tobacco worms were sparingly eaten by bobwhites at Marshall Hall,

but experiments indicated that they may eat them in greater numbers when opportunity offers. Five tobacco worms (*Phlegethontius sexta*), two-thirds grown, placed in a cage with three captive bobwhites, July 8, 1903, were devoured in less than two minutes. Cabbage worms (*Pontia rapæ*) and cutworms also were offered and greedily eaten.

LIST OF CATERPILLARS EATEN.

Army worm (*Heliophila unipuncta*).
Cutworm (*Agrotis* sp.).
Cutworm (*Feltia annexa*).
Noctuid moth (*Noctuidæ*).
Cotton worm (*Alabama argillacea*).
Cotton bollworm (*Heliothis obsoleta*).
Striped garden caterpillar (*Manestra legitima*).
Yellow bear caterpillar (*Diacrisia virginica*).
Pyralid (*Tholeria reversalis*).
Purslane sphinx (*Deilephila gallii*).
Southern tobacco worm (*Phlegethontius sexta*).
Caterpillar (*Junonia cœnia*).
Pupa (*Vanessa* sp.).

MISCELLANEOUS ANIMAL FOOD.

Insects of several orders not previously mentioned make up 0.70 per cent of the food of the bobwhite. They include hymenopterous insects, such as ants (*Lasius* sp., *Tetramorium cæspitum*, *Camponotus pennsylvanicus*); gall flies (*Cynipidæ*), which produce bladderlike growths on plants; in rare instances parasitic wasps (*Tiphia inornata* and *Proctotrypes rufipes*); crane flies, May flies, and sometimes true flies, like the green fly (*Lucilia cæsar*) and the robber fly (*Asilidæ*). The animal food of the bird includes other orders besides insects. The greater part of this is spiders, chiefly ground spiders, with a few harvest spiders (*Phalangidæ*). The common thousand leg (*Julus* sp.) sometimes contributes to the food, as it often does to that of many species of song birds. Snails are more often taken. Among these *Pupa armifera* and the pond snail (*Succinea avara*) have been identified. The little fresh-water lobster called crayfish (*Cambarus*) had furnished the major course for 4 out of 15 birds shot by collectors for S. A. Forbes in Illinois. Manipulation of these biting crustaceans would appear to be difficult for a bird no larger than bobwhite. The queerest food eaten is the toad. B. H. Warren reported Florida birds as feeding on small batrachians (probably young toads), and laboratory examination of Florida birds showed in one case a tiny toad. It is fortunate that this habit of bobwhite is not general, since the toad is useful and destroys great numbers of insects.

FOOD OF THE YOUNG.

During the breeding season a third of the food of adult bobwhites consists of insects, while their young, like those of practically all other land birds, consume a much greater proportion of insect food than

do their parents. At Marshall Hall, July 24, 19 droppings collected from two broods of downy chicks—one but a few hours out of the shell and the other probably several days old—consisted wholly of the remains of insects. Their fragmentary condition made the species almost unrecognizable, but the following were identified:

Minute green leaf-eating beetles (*Chrysomelidæ*), at least two species.
Leaf-eating beetle (*Colaspis brunnea*).
Small scarabæid beetles (*Scarabæidæ*), two species.
Longicorn beetle (*Cerambycidæ*), one species.
Ground beetles (*Carabidæ*), five species.
Weevils (*Rhynchophora*).
Grasshopper (*Acrididæ*).
Caterpillars (*Lepidoptera*).
Ants (*Formicidæ*).
Stink bug (*Euschistus?*).
Spiders (*Arachnida*).
Thousand legs (*Julus* sp.).

MASKED BOBWHITE.

(*Colinus ridgwayi.*)

The masked bobwhite is slightly smaller than the bobwhite of the Eastern States, and the male differs strikingly, having the chin, throat, and sides of the head black, and the underside of the body usually uniform rusty reddish. Since the discovery of the bird little has been added to our knowledge of its life history beyond some notes on its distribution, and the fact of its probable extinction within our borders. It lived on grassy plains covering a limited area in southern Arizona, south and southwest of Tucson, and ranged into northern Sonora, Mexico. In regard to the causes leading to the disappearance of the masked bobwhite, Herbert Brown writes as follows:

> The causes leading to the extermination of the Arizona masked bobwhite (*Colinus ridgwayi*) are due to the overstocking of the country with cattle, supplemented by several rainless years. This combination practically stripped the country bare of vegetation. Of their range the *Colinus* occupied only certain restricted portions, and when their food and shelter had been trodden out of existence by thousands of hunger-dying stock, there was nothing left for poor little bobwhite to do but go out with them. As the conditions in Sonora were similar to those in Arizona, birds and cattle suffered in common. The Arizona bobwhite would have thriven well in an agricultural country, in brushy fence corners, tangled thickets, and weed-covered fields, but such things were not to be had in their habitat. Unless a few can still be found on the Upper Santa Cruz we can, in truth, bid them a final good-by.[a]

Recent information received by the Biological Survey from Sonora is to the effect that these interesting birds still survive in parts of that region, and efforts are being made by a game association to obtain living birds from there to introduce into California. The natural home of the masked bobwhite, in the hot and arid desert of southern

[a] Auk., XXI, p. 213, April, 1904.

Arizona and northern Sonora, is sufficient guaranty that the birds would thrive in cultivated sections anywhere in southern California and the arid Southwest. It would be deplorable if so handsome and useful a bird should be allowed to become extinct, and a determined effort should be made to introduce it into suitable localities before it is too late.

Beyond what Herbert Brown has stated we have practically nothing on this bird's habits. He has told us that, like all the birds of the genus *Colinus*, the males give the well-known 'bobwhite' call, and he translates their rallying note as 'hoo-we.' He examined the stomachs of three birds. The first contained mustard seed, chaparral berries, six or eight beetles, and other insects; the second only a single grasshopper an inch long, and the third contained 20 ants, several crescent-shaped seeds, and a large number of small, fleshy green leaves.

It is stated by Bendire that in Sonora Benson found these birds only in fields where wheat and barley had been grown. Probably then the bird's general habits may be safely assumed to be similar to those of its relative, bobwhite.

CALIFORNIA QUAIL.

(*Lophortyx californicus.*)[a]

The California quail is generally dispersed over California below an altitude of 8,000 feet and extends into southern Oregon and western Nevada. It has been introduced into Washington and British Columbia, and efforts to introduce it into the Hawaiian Islands also have proved very successful, although of late years its numbers there have been much reduced by the mongoose, by which in time it is likely to be exterminated. Two geographic forms of the bird are recognized, a dark form and a light one, but as they do not differ in habits they are not distinguished in the following account. It is a beautiful bird with a most pleasing combination of colors and markings, its head being adorned by a glossy black crest, narrow at the base and gradually widening into gracefully recurving plumes, and the markings on the underparts resembling scales. It frequents brush-covered hillsides, canyons, thickets along water courses and the borders of roads, as well as vineyards and other cultivated fields. The nesting time of the species varies considerably according to locality and conditions. According to E. A. Mearns it nests in March and April in Ventura County, Cal. Nests containing eggs were found

[a] This name is used here to cover both the typical California quail (*Lophortyx californicus*) and the paler, more southerly form, called the valley quail (*L. c. vallicola*).

during the last week of May in Tulare County, Cal., by J. E. McLellan. The eggs usually number 12 to 15, and are white or buff with spots.

These birds take kindly to civilization, and flocks are not rarely seen in the suburbs of large towns, where they range through the gardens and orchards. They often nest close to farm buildings, and W. Otto Emerson states that a pair nested within a rod of his front door, though nearly every hour people and vehicles were passing within four feet of the nest.

Instead of spending the night in a circle on the ground, like the bobwhite, the California quail chooses much safer places and roosts in bushes or low thickly foliaged trees. This quail is even more confiding than the bobwhite, and frequently comes about farm buildings to eat with the chickens. It has been known to lay in confinement, and appears to yield readily to semidomestication.

The valley quail has acquired the interesting habit of posting sentinels when feeding, which is described in detail by John J. Williams. Mr. Williams observed a flock enter a field and begin to feed, while a sentinel took his station in a peach tree and scanned the country round about for danger. Presently he was relieved by a second bird, who took up a position on a brush pile and a little later was relieved by a third, who kept guard while the other two fed with the flock.[a]

Writing in 1891 Clark P. Streator says that about 100,000 are sold each year in the San Francisco market. It is not a perfect game bird, for it does not lie well to a dog, and when once flushed has a habit of running that is exasperating to the sportsman. The best way to hunt these quail is to keep the dog at heel and to run down the birds. This is likely to make them take wing and to break up the covey. The same result may be accomplished also by discharging the gun in the air. When a covey has been scattered in suitable cover they will lie well enough to a trained dog to give the hunter considerable sport, though it is poor in comparison with that afforded by the bobwhite. The beauty of this quail, its pleasant call notes, and its confidence in man make it a favorite, except where it damages the grape crop. In fall and winter where it is abundant hundreds of birds unite in great packs. Bendire, writing in 1892, says that within a decade packs of 500 were often found, but that at that time coveys even of 50 were rare in most places.[b] In the fall of 1891 they were still very abundant on the west side of the San Joaquin Valley, where E. W. Nelson, of the Biological Survey, records their slaughter by pot hunters. The hunters stationed themselves behind a brush blind near the one spring where the birds came to drink. Thousands of them flocked

[a] Condor, vol. 5, pp. 146–148, 1903.

[b] Life Hist. N. Am. Birds [I], p. 24, 1892.

thither for water during the day, and by waiting until many birds were bunched the hunters killed at least a score at each discharge of the gun. In a week of this butchery 8,400 quails were killed. A record of 525 birds to four guns in a day in February, 1903, near San Diego, Cal., shows that birds are still abundant there, though far less numerous in most places than formerly.[a]

The California quail, though not a large consumer of insects, is a useful bird, since weed seeds constitute more than half of its food. In some regions these birds suffer from the curtailment of their food supply by droughts, and in the northern part of their range many are killed by severe winters. Bendire states that during the excessively cold winter of 1887–88, when the mercury dropped to 28° below zero in the northeastern corner of California, these quail perished in great numbers.[b]

The California quail might be introduced successfully in many sections between California and Texas where it does not occur at present. It already has been introduced into Colorado, where it will be protected by law at all seasons until 1920. Laws to prevent trapping and to limit the day's bag, together with absolute protection in sections where necessary, should suffice to preserve this beautiful species.

FOOD HABITS.

The general food habits of this quail have been ascertained by the examination of 601 stomachs, and it proves to be one of the most largely vegetarian of game birds. The material for investigation was collected in California, and represents every month of the year except May. Insects furnished but 2.15 per cent of the food, and leaves, seeds, and fruit 97.85 per cent.

Insect and Other Animal Food.

The 2.15 per cent of animal food eaten by this quail is distributed as follows: Spiders, 0.03 per cent; beetles, 0.22 per cent; grasshoppers and crickets, 0.24 per cent; ants and other Hymenoptera, 0.67 per cent; miscellaneous insects, 0.99 per cent. The beetles are both adults and larvæ, and belong to the following families: *Chrysomelidæ* (leaf-eating beetles), *Tenebrionidæ* (darkling beetles), *Elateridæ* (wireworms), *Carabidæ* (ground beetles), *Dermestidæ* (dermestids), *Coccinellidæ* (ladybirds), and snout beetles (suborder *Rhynchophora*). The leaf-eating beetles include *Diabrotica soror*, a western representative of the destructive twelve-spotted cucumber beetle. Flea beetles also are eaten, including species of the genus *Haltica*. Among the

[a] Recreation, vol. 18, p. 368, 1893.

[b] Life Hist. N. Am. Birds [I], p. 26, 1892.

miscellaneous leaf-eating beetles may be mentioned the brilliant *Gastroidea cæsia*. Conspicuous among the ground beetles eaten is the common *Agonoderus pallipes*, and among the useful predaceous ladybirds the species *Hippodamia convergens*. Like the eastern bobwhite, the California quail feeds on ants of the families *Formicidæ* and *Myrmicidæ*. Sometimes 20 to 35 ants are taken at a meal. Of the other Hymenoptera, gall insects (*Cynipidæ*) and their galls make a significant proportion. Caterpillars and their pupæ are eaten. Cutworms (*Agrotis*), measuring worms (*Geometridæ*), sphinx caterpillars (including *Deilephila*), and the cotton bollworm (*Heliothis obsoleta*) make up the greater part of this food. Like the bobwhite again, this bird shows a relish for bugs. It eats leaf bugs (*Capsidæ*), bugs of the chinch bug family, such as *Lygæus truculentis* and *L. bitriangularis*, and stink bugs (*Pentatomidæ*), assassin bugs (*Reduviidæ*), flat bugs (*Aradidæ*), burrower bugs (*Crytomenus*), leaf hoppers (*Jassidæ*), tree hoppers (*Membracidæ*), plant lice, and bugs of the genus *Scolops* (*Fulgoridæ*). The miscellaneous animal matter taken includes flies (*Lucillia cæsar*), spiders, and snails.

Vegetable Food.

Fruit.

The vegetable food of this quail amounts to 97.85 per cent of its diet. The bird has an unsavory reputation among fruit growers, especially the owners of vineyards. Relative to this subject, Miss Florence A. Merriam, writing from San Diego County, Cal., says:

> In fact, the quail were so abundant as to be a pest. For several years great flocks of them came down the canyons to Major Merriam's vineyard, where they destroyed annually from twenty to thirty tons of fruit. In one season—July to October, 1881—one hundred and thirty dozen [1,560] were trapped on his ranch. The result of this wholesale destruction was manifest when I returned to the valley in 1894. The birds were then rarely seen on the roads and seldom flushed in riding about the valley.[a]

When this species becomes superabundant and plays havoc with crops it is well to remember that it can be so easily checked. W. H. Osgood, of the Biological Survey, has furnished the writer data on the frugivorous habits of the quail in central California. In one vineyard he saw a flock of about a thousand eating zinfandel grapes. The birds do much damage in September, when the young are molting and they have collected in packs, as before described.

Walter E. Bryant, writing of the damage to fruit, offers testimony on the other side:

> In some parts of California there is a strong prejudice against the quail, owing to alleged damage to the grape. The evidence which I have thus far gathered shows that the quail do pick at the bunches of grapes, and not alone

[a] Auk, XIII, p. 116, 1896.

those bunches which are near or on the ground; but the damage which they cause seems overestimated. Too often mutilated bunches of grapes are supposed to be due to the presence of quail in the vineyard; but there are other birds and mammals, also, which vary their diet with grapes. I have examined a number of quail's crops and gizzards without finding the presence of grapes, although the birds had been shot near and in vineyards. A quail's crop sent to me from Los Gatos, by Mr. A. H. Hawley, contained twenty-five small grapes; others had a few grapes, seeds, and poison-oak berries.[a]

In the 601 stomachs of the valley quail examined by the Biological Survey grapes formed only 0.01 per cent of the annual food. This small quantity is due, no doubt, to the fact that many of the birds were shot in regions remote from vineyards and many of them during the time when grapes were not in fruit. The total proportion of all kinds of fruit was only 7.60 per cent, an amount so insignificant as to preclude the idea of serious damage. Where the birds are overabundant and the consequent damage great, trapping or advertising the conditions in sporting papers will probably result in reducing the numbers to normal. Of the 7.60 per cent of fruit, grapes, as before stated, contribute 0.01 per cent; plants of the genus *Rhus*, mainly *Rhus diversiloba*, 4.74 per cent, and miscellaneous fruit, prunes, and vaccinium, 2.85 per cent. The maximum quantity of fruit, amounting to 32.40 per cent for the month, was taken in December, after the grapes had been picked.

GRAIN.

The relations of the California quail to grain are of considerable economic importance. W. T. Craig, of San Francisco, writes to the Department of Agriculture: "I have observed the quail enter a field of wheat to the number of thousands, and had they not been driven away they would have destroyed the whole crop." No other reports to the Biological Survey show the danger to grain from this quail to be so serious, but data at hand show that it does more or less damage to germinating grain. Two quail shot by Walter E. Bryant on a newly-sown grain field had eaten, respectively, 185 kernels and 210 kernels of barley.[b] Barley is important in California, where it is grown for hay, for grain feed, and for beer making. There is, however, much volunteer barley, which many species of birds feed on and thus do good rather than harm. It is probable that quail do little or no harm to barley at harvest time, and the waste grain that they subsequently gather in stubble fields has no positive value. Of the yearly food of the 601 quail examined 6.18 per cent was grain, divided as follows: Barley, 4.58 per cent; wheat, 0.44 per cent; corn and oats, 1.16 per cent.

[a] Zoe, IV, p. 56, 1893.

[b] Zoe, IV, p. 55, 1893.

LEAVES.

In its habit of feeding on foliage the California quail differs from the bobwhite and resembles the ruffed grouse. Such food forms 22.73 per cent of the vegetable matter eaten. In February, when the bobwhite is weathering blizzards, the California quail is enjoying balmy weather and feeding on browse to the extent of 80 per cent of its food. Most of this browse consists of leaves of leguminous plants, principally clovers. Bur clover (*Medicago denticulata*), a weed that grows in cultivated land and along irrigation ditches, appears to supply most of the forage. Alfalfa and clovers of the genus alfalfa form most of the remaining leguminous green food. Next to legumes the finely divided leaves of alfilaria, or 'filaree' (*Erodium*), are important. Grass, chickweed (*Alsine media*), the leaves of fern, geranium, oxalis, and groundsel-bush (*Baccharis*) also furnish forage for the quail. W. W. Cooke reports that near Grand Junction, Colo., where the California coast quail has been introduced and thrives wonderfully, market gardeners regard it as a nuisance.[a]

WEED SEEDS.

Different seeds, largely of weeds, furnish the California quail 59.77 per cent of its year's diet. Legumes contribute 17.87 per cent; alfilaria, 13.38 per cent; compositæ, 5.55 per cent; the spurge family (*Euphorbiaceæ*), 5.85 per cent, and miscellaneous plants 17.12 per cent. Leguminous seeds are liked best by the bird, and make up 17.87 per cent of the seed diet for the year and 46.1 per cent of its food for June. Bur clover yields abundance of seeds as well as forage. Its seed pod is peculiar, much elongated, beset with long, sharp spines, and spirally coiled into a roundish bur. The quail swallows it whole, regardless of spines. This food is highly nutritious and is relished by stock as well as by birds and wild mammals. Seeds of closely allied plants, such as alfalfa, vetch, cassias, cultivated beans and peas, and clovers of the genera *Trifolium*, *Lespedeza*, and *Melilotus* also are in the quail's list, as well as of locust (*Robinia*) and lupines, the latter taken in large quantities. They include the seeds of *Lupinus nanus*, *L. micranthus*, and *L. sparsiflorus*. Other leguminous seeds are eaten in great numbers, including a small bean-like seed, *Lotus glaber*, which looks much like a miniature Frankfurt sausage, and an unidentified, almost microscopic square seed, with a notch in its edge, possibly some species of birdsfoot trefoil (*Lotus*). Nearly all of the leguminous plants that furnish the quail with seeds belong in the category of weeds.

Seeds of weeds from other families of plants make up no less than

[a] Birds of Colorado, App. 2, p. 202, 1900.

41.89 per cent of the annual food. Seeds of compositæ yield 5.55 per cent, such injurious weeds as thistles making up the largest part of this percentage. The thistles most often eaten are *Centaurea melitensis*, *C. americana*, *C. solstitialis*, *Mariana mariniana*, *Sonchus* sp., and *Carduus* sp. *M. mariniana* has the largest seeds. Ninety of these had been eaten by a quail shot by F. E. L. Beal at Haywards, Cal., August 15, 1903. The seeds of the bur thistle (*Centaurea melitensis*) are smaller and have a hook at one end and a set of spines like a paint brush at the other. They are, perhaps, most liked of all composite seeds. From 500 to 800 are often eaten at a meal. The destruction of this seed is highly beneficial, for the bur thistle is troublesome to farmers. Wild carrot (*Daucus carota*), tar weed (*Madia sativa*), wild lettuce (*Lactuca* sp.), mayweed (*Anthemis cotula*), and marsh elder (*Iva xanthifolia*) furnish most of the remaining seeds of composite plants. Tar weed is a favorite source of food, and one stomach, collected at Watsonville, Cal., by J. S. Hunter, contained 700 of these seeds. Another stomach, from the same place, held 2,000 tiny seeds of dog fennel, or mayweed. (Fig. 4.)

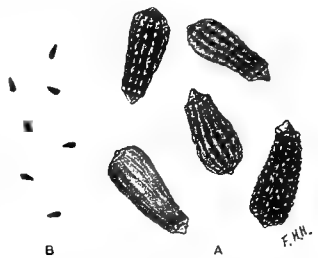


FIG. 4.—Seed of mayweed (*Anthemis cotula*). (From Bull. 38, Nevada Agricultural Experiment Station.)

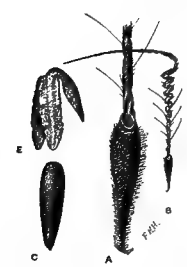


FIG. 5.—Seed of alfilaria (*Erodium cicutarium*). (From Bull. 38, Nevada Agricultural Experiment Station.)

From seeds of plants belonging to the spurge family (*Euphorbiacea*) come 5.85 per cent of the annual food. Spurges, particularly *Croton setigerus*, commonly known as turkey mullein, are a staple with the California quail as with most other seed-eating birds. So fond are the quail of turkey mullein that their crops are often completely distended with the seeds, sometimes from 500 to 900 to a bird. Turkey mullein is a prostrate plant covered with a whitish, woolly pubescence, and often used by the Indians to poison fish. Seeds of alfilaria (*Erodium cicutarium* and other species), which is both a weed and a forage plant, are eagerly sought. They are lance-shaped, furnished with a long, elaborate, corkscrew awn ending in a thin spine. They burrow into sheep's wool and even pierce the skin. The alfilaria is one of the few seeds of the West that all seed-eating birds consume. The plant is very

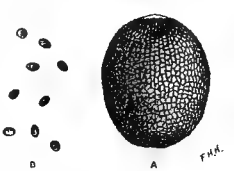


FIG. 6.—Seed of black mustard (*Brassica nigra*). (From Bull. 38, Nevada Agricultural Experiment Station.)

abundant in California, and the quail often eats from 1,000 to 1,600 of the little corkscrew seeds at a meal. It affords 13.38 per cent of the year's food, and 26.70 per cent of the June diet. (Fig. 5.)

Seeds of miscellaneous weeds comprise 17.11 per cent of the annual food. Among the species included are pigweed (*Chenopodium al-*

FIG. 7.—Seed of chickweed (*Alsine media*). (From Bull. 47, Nevada Agricultural Experiment Station.)

bum), rough pigweed (*Amaranthus retroflexus*), and black mustard (*Brassica nigra*) (fig. 6)—especially obnoxious in grain fields—and the closely related weed, wild radish (*Raphanus sativus*). Seeds of shepherd's purse (*Bursa bursa-pastoris*) and of other cruciferous

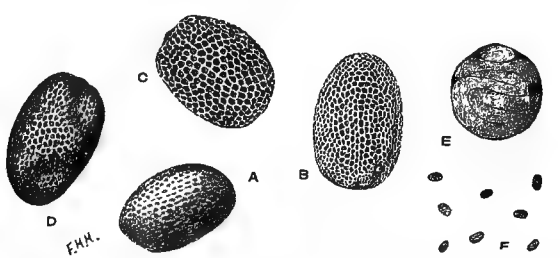


FIG. 8.—Seed of *Geranium dissectum*. (From Bull. 47, Nevada Agricultural Experiment Station.)

plants are included in common with *silene* and the chickweeds (*Cerastium* sp. and *Alsine media*) (fig. 7). Geranium seeds (fig. 8) are so much relished that often 300 or 400 are eaten at a time. Two closely related plants, miner's lettuce (*Montia perfoliata*) and red

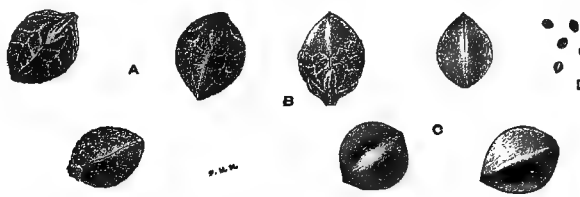


FIG. 9.—Seed of sorrel (*Rumex acetosella*). (From Bull. 47, Nevada Agricultural Experiment Station.)

maids (*Calandrinia menziesii*), bear minute shiny black seeds that often are eaten by the thousand. The little seeds of red sorrel (*Rumex acetosella*) (fig. 9) and curled dock (*Rumex crispus*) are occasionally taken in almost as large numbers. Seeds of chess (*Bromus*

secalinus (fig. 10) and *Bromus hordeaceus*), a serious grain pest, are relished, and hundreds of the grain-like seeds of the grass known as 'poison darnel' (*Lolium temulentum*) appear in crops examined. Macoun, quoting Spreadborough, states that in British Columbia, where it winters successfully, the quail finds shelter in severe weather under the broom (*Cytisus scoparius*), which in places grows abundantly and yields seed for subsistence.[a]

The quail feeds also at times on mast. A. K. Fisher, in the western foothills of the Sierra Nevada, the last of July found both young and adult quail eating young acorns.[b] Small quantities of sedge seeds (*Carex* and *Scirpus*) and of dodder (*Cuscuta*) are eaten, the latter plant being a destructive parasite on leguminous forage crops. The miscellaneous seed list includes also stick seeds (*Lappula* sp.), buttercup (*Ranunculus* sp.), bind weed (*Convolvulus* sp.), *Amsinckia* sp., *Anagallis arvensis*, plaintain (*Plantago major*), ribgrass (*Plantago lanceolata*), painted cup (*Castilleja* sp.), mountain lilac

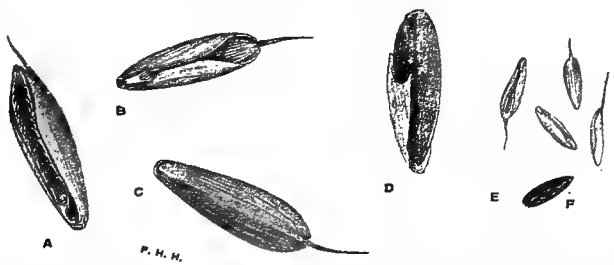


FIG. 10.—Seed of chess (*Bromus secalinus*). (From Bull. 47, Nevada Agricultural Experiment Station.)

(*Ceanothus* sp.), and black wattle (*Callicoma serratifolia*). In the mountains of Lower California the food supply determines the breeding time of birds. If there is not enough rain for a good supply of seeds the coveys of quail do not break up into nesting pairs but remain in coveys throughout the summer. If the season is wet and the winter rains promise abundant food the birds mate in March and begin nesting immediately.[c]

FOOD OF THE YOUNG.

The food of young birds differs from that of the parents, as has already been remarked of the bobwhite, but the difference is less marked with the California quail. Stomachs of 32 young of the western birds, from one-fourth to one-half grown, have been examined. They were collected from the middle of July to the middle of September. The food was composed of 3.4 per cent animal matter

[a] Cat. Can. Birds, Part I, p. 198, 1900.
[b] N. A. Fauna, No. 7, p. 28, 1893.
[c] Life Hist. N. A. Birds [I], p. 27, 1892.

and 96.6 per cent vegetable matter. Thirty-nine adult birds shot in the same period had eaten almost entirely vegetable food, since only 0.6 per cent of animal food appeared in analysis. Had the young birds been collected when newly hatched, undoubtedly a larger proportion of insect food would have been found. The 3.4 per cent of insect food mentioned consisted of beetles, 0.1 per cent; bugs, 0.2 per cent; grasshoppers, 1.3 per cent, and ants, 1.8 per cent.

The vegetable food of the young is much like that of the adult. In this case it consisted of leguminous seeds, 18.1 per cent; alfilaria seeds, 18.5 per cent; miscellaneous seeds, 54.4 per cent; browse, 6.6 per cent; grain, 0.6 per cent, and miscellaneous vegetable matter, 0.4 per cent.

GAMBEL QUAIL.

(*Lophortyx gambeli.*)

[PLATE II.]

The Gambel quail in general appearance is much like the valley quail, but, among other differences, lacks the scalelike feathers of the lower parts and has considerable chestnut along the flanks. It lives in the Lower Sonoran zone, from western Texas to southeastern California and from southern Utah and Nevada south through central Sonora, Mexico. The desert is its home, but it is rarely found far from water. Its favorite haunts are patches of bushy vegetation, such as mesquite, mimosa, creosote, and patches of prickly pear. It frequently takes up its abode about cultivated land, living in alfalfa fields or nesting in vineyards.

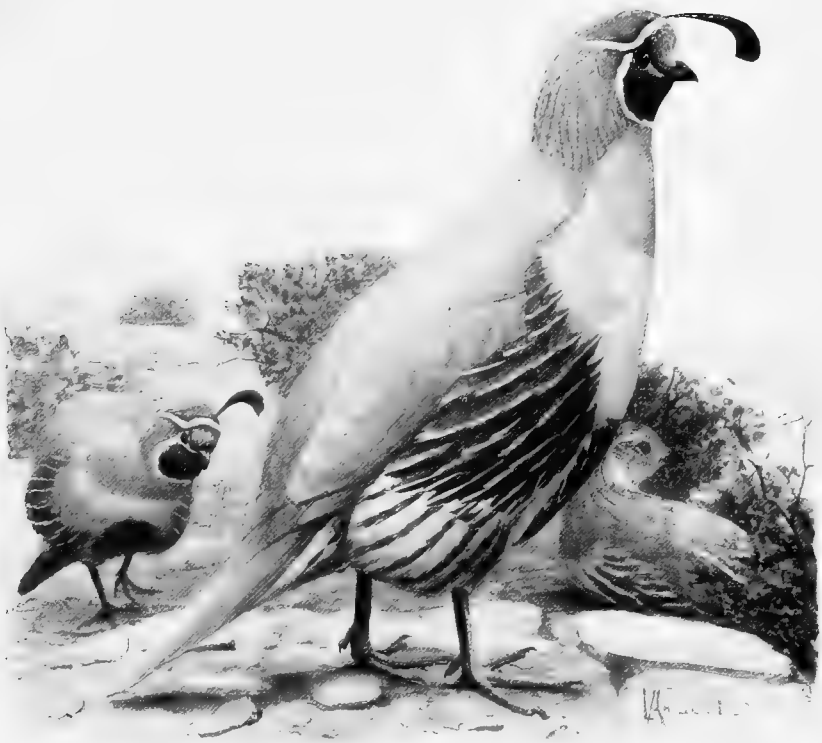
An interesting account of the habits of the Gambel quail in the Pahrump Valley, Nevada, is given by E. W. Nelson:

> I noticed that when a flock of quail came to feed on grain left by the horses an old male usually mounted the top of a tall bush close by and remained on guard for ten or fifteen minutes; then, if everything was quiet, he would fly down among his companions. At the first alarm the flock would take to the bushes, running swiftly, or flying when hard pressed. They roosted in the dense bunches of willows and cottonwoods growing along the ditches. * * * When feeding they have a series of low clucking and cooing notes which are kept up almost continually.[a]

The love note, according to Coues, may be represented in words as 'killink, killink.' Nesting takes place in April, sometimes not till May. About a dozen eggs usually constitute a clutch. In sections where this quail is still numerous the birds *pack* in bands of from 100 to 500 after the breeding season.

From the sportsman's point of view the Gambel quail as a game bird does not approach the bobwhite. It will sometimes lie to a dog

[a] N. A. Fauna, No. 7, pp. 29, 30, 1893.



GAMBEL QUAIL (LOPHORTYX GAMBELI).

fairly well, but as a rule it takes to its legs with all haste and leaves the dog on point, to the vexation of the hunter. It is, however, a useful species, which brightens the desert with its presence and contributes a welcome addition to the fare of the traveler. While less valuable than the bobwhite as a destroyer of noxious insects and as an object of sport, this bird well deserves protection for its food value and its beauty. It thrives under desert conditions and might be successfully introduced in the arid regions of Colorado, New Mexico, and Texas.

FOOD HABITS.

Stomachs of 28 birds collected mainly in Arizona and Utah, from January to June, have been examined. Only 0.48 per cent of the food consisted of insects; the remaining 99.52 per cent was vegetable matter. Like the valley quail, this is one of our least insectivorous birds. Its insect diet includes ants, beetles, grasshoppers, leaf hoppers (*Membracidæ*), and stink bugs (*Pentatomidæ*). Among the beetles are the western twelve-spotted cucumber beetle (*Diabrotica soror*) and *D. tenella*. The young chicks, however, will doubtless be found highly insectivorous and therefore useful.

The vegetable food of Gambel quail was made up as follows: Grain, 3.89 per cent, miscellaneous seeds, 31.89 per cent, and leaves and plant shoots, 63.74 per cent. From the present investigation the bird appears less frugivorous than any of the other American quails, for not one of the 28 stomachs contained fruit. Observers, however, say that the bird is somewhat frugivorous, and no doubt in a country well stocked with berries and fruit it would rapidly develop a frugivorous taste. Baird, Brewer, and Ridgway, for instance, state that during summer it makes its home in patches of *Solanum* and feeds on the tolerably palatable fruit, and also that it is known to eat gooseberries.[a] Coues says: "In the fall it gathers cherries and grapes. * * * It visits patches of prickly pear (*Opuntia*) to feed upon the soft juicy 'Tunas' that are eaten by everything in Arizona, from men and bears to beetles."[b]

The grain eaten by the Gambel quail was corn, wheat, and oats. In flocks numbering from 50 to 100, it feeds about grain stacks with domestic poultry. It is even more industrious as a browser on foliage than the valley quail. Succulent foliage and shoots form 63.74 per cent of its food. Much of this comes from alfalfa, bur clover, and the foliage of other legumes. Vernon Bailey, of the Biological Survey, says that at St. Thomas, Ariz., in January, 1889, this quail fairly swarmed on alfalfa fields, feeding on the green leaves and pods. He found flocks of from 25 to 50 in such situations, and during a

[a] Birds of Northwest, p. 434, 1874. [b] Hist. N. Am. Birds, III, p. 483, 1874.

five minutes' walk often saw a hundred birds. The same observer, when in Mohave County, Ariz., found that the bird fed principally on juicy plants when it could not procure water. At times it eats grass and its inflorescence, and it has been known to devour showy flowers. In spring it shows a fondness for buds. Baird, Brewer, and Ridgway note that then it feeds largely on the willow buds, which impart to its flesh a distinctly bitter taste.[a]

The seed-eating habits of Gambel quail closely resemble those of the valley quail. Leguminous plants furnish the largest part of the seed food—21.17 per cent of the annual diet—alfalfa, bur clover, and kindred plants appearing to be preferred, but cassias, acacias, and lupines also are taken, as well as the beans of the mesquite, which in many places are a staple with birds and mammals. The seeds of alfilaria (*Erodium cicutarium*), another bird staple, furnish 2.28 per cent of the year's food. Miscellaneous seeds form 8.44 per cent. They are obtained from grasses, mallows (*Malva*), and such cruciferous plants as mustard (*Brassica*) and peppergrass (*Lepidium*); also from chickweed (*Cerastium*) and *Atriplex*.

MOUNTAIN QUAIL.

(*Oreortyx pictus.*[b])

The mountain quail occurs in the forested mountains of the humid Transition Zone of the Pacific coast, from Santa Barbara, Cal., to Washington, and in the mountains of the more arid Transition Zone on the west side of the Cascades in northern Oregeon and south over the Sierra Nevada to northern Lower California. The birds of the Sierra Nevada winter at lower altitudes than they nest, but those of the coast mountains do not make this vertical migration. This species is the largest and among the handsomest of American quail, with two long jet-black crest plumes and rich chestnut throat and flanks, the latter broadly banded transversely with spotless white.

The nests of the mountain quail are placed on the ground and usually contain 10 to 12 eggs, which vary from pale-cream color to a much darker due. At Tillamook, Oreg., June 30 and July 4, 1897, A. K. Fisher found newly hatched chicks; and at Donner, Cal., July 11 and 19, at an altitude ranging from 6,100 to 8,000 feet, Vernon Bailey found nine broods, varying in age from newly hatched chicks to half-grown birds. Bendire, quoting L. W. Green, of the United States Fish Commission, says that the earliest date of the nesting of

[a] Hist. N. Am. Birds, III, p. 485, 1874.

[b] The name is used here to cover both the typical dark birds of the humid coast forests (*Oreortyx pictus*) and the paler one (*O. p. plumiferus*) of the more arid Transition Zone in the Sierras and Cascades.

the plumed mountain quail (*Oreortyx p. plumiferus*) known to him was April 15, and the latest, August 15. He states also that the cock bird takes care of the young.[a] Chester Barlow, in writing of the habits of the mountain quail, says that at Fyffe, Cal., it begins to nest the last of May or early in June. All nests that he found were built in a growth of 'mountain misery' (*Chamæbatia* sp.) 8 to 10 inches high.[b] On Mount Tallac and the higher slopes of Pyramid Peak, W. W. Price found newly hatched young as late as August 15. He noted that by September 1 the quail became restless and soon began their peculiar migration from the east slope to the west slope of the Sierras. From 4 to 6 adults with their young form a small band of from 10 to 30 individuals, and pursue their way almost wholly on foot to a more congenial winter climate; and by October 1 all had abandoned elevations above 5,000 feet. In spring they migrate back singly or in pairs.[c]

There are many admirers of this bird because of its exquisite plumage, but most sportsmen prefer a game bird that lies better to the dog. Its flesh is excellent, and the bird sells well in the market. H. W. Henshaw reports that in the late fall of 1880 he found the markets of Portland, Oreg., well supplied with live mountain quails which had been trapped in the neighboring mountains, cooped, and sent to the city for sale. Nowhere is it so numerous as the California quail, or the bobwhite in the Southern States, and it is more of a forest-loving species than any other American quail. The mountain quail sometimes enters cleared fields, but so far as the records of the Biological Survey show it does no appreciable damage to cultivated fruits or other crops and it is a useful destroyer of weed seeds.

FOOD HABITS.

No stomachs of the mountain quail of the humid regions were available for examination, but Sandys writes that the bird feeds on insects and various seeds, including grain,[d] and Elliot says it sometimes approaches farm buildings in search of scattered kernels of grain.[e]

The food of the mountain quail of the arid regions has been studied in the laboratory of the Biological Survey. The stomachs examined, 23 in number, were collected in California. Five were collected in January, 2 in May, 6 in June, 3 in July, 3 in August, and

[a] Life Hist. N. Am. Birds [I], p. 16, 1892.
[b] Condor, 3, p. 158, 1901.
[c] Condor, 3, pp. 158, 160, 1901.
[d] Upland Game Birds, p. 93, 1902.
[e] Gallinaceous Game Birds N. A., p. 42, 1897.

6 in November. The food consisted of animal matter, 3 per cent, and vegetable matter, 97 per cent. The animal food was made up of grasshoppers, 0.05 per cent; beetles, 0.23 per cent; miscellaneous insects, including ants and lepidopterous pupæ, 1.90 per cent; and centipedes and harvest spiders (*Phalangidæ*), 0.82 per cent. Among the beetles was a species of the firefly family (*Lampyridæ*), a ground beetle (*Carabidæ*), and a leaf beetle (*Haltica* sp.). Vernon Bailey informs the writer that the young eat many ants. The vegetable food consisted of grain, 18.20 per cent; seeds, practically all of weeds or other worthless plants, 46.61 per cent; fruit, 8.11 per cent; and miscellaneous vegetable matter, 24.08 per cent. The grain included wheat, corn, barley, and oats. Of the seed element the seeds of grasses formed 7.78 per cent; of legumes, 10.41 per cent; of weeds of the family *Euphorbiaceæ*, 3.16 per cent; of alfilaria (*Erodium cicutarium*), 2.76 per cent; and of miscellaneous weeds, 22.50 per cent. The legume seeds include seeds of alfalfa, cassia, bush clover, vetch, and lupine. The miscellaneous seeds come from wild carrot (*Daucus carota*), tar weed (*Madia sativa*), *Collomia* sp., *Amsinckia* sp., labiate plants, dwarf oak, snowbush (*Ceanothus cordulatus*), and thistle.

Concerning the feeding habits of mountain quail of the dry country (*O. p. plumiferus*), J. E. McClellan says: "Their feeding hours are early in the morning and just before sundown in the evening, when they go to roost in the thick tops of the scrub live oaks. Their feeding habits are similar to those of the domestic hen. They are vigorous scratchers, and will jump a foot or more from the ground to nip off leaves."[a] This bird is especially fond of the leaves of clover and other leguminous plants. It feeds also on flowers, being known to select those of Compositæ and blue-eyed grass (*Sisyrinchium*). Flowers, leaves, buds, and other kinds of vegetable matter form the 24.08 per cent marked miscellaneous. The birds probably eat more fruit than these stomach examinations indicate. Lyman Belding says that this quail feeds on service berries, and that during certain seasons it lives almost entirely on grass bulbs (*Melica bulbosa*), which it gets by scratching, for which its large, powerful feet are well adapted. The fruit in its bill of fare includes gooseberries, service berries (*Amelanchier alnifolia*), and grapes (*Vitis californica*). The bird is probably fond also of manzanita berries, for it is often seen among these shrubs.

[a] MS. Records, Biological Survey.

SCALED QUAIL.

(*Callipepla squamata.*)[a]

The 'cotton top,' or scaled quail, as it is commonly known, is bluish gray on the back, with black-edged feathers on the under parts, which appear like large scales. Its conspicuous white-tipped crest has given it the local name of cotton top. It is found in southern Colorado and in the Upper and Lower Sonoran zones from Arizona to western and southern Texas and south to the Valley of Mexico. The birds of the lower Rio Grande region are darker than those farther west. According to Bendire, this quail lives on open arid plains overgrown with yucca, cactus, and sagebrush, and often gathers in coveys numbering 25 to 80. It lays about a dozen eggs, and he believes that two or three broods are reared in a season. The cock assists in the care of the young, but not in incubation.[b]

FOOD HABITS.

The food habits of this game bird are of especial interest. Stomachs and crops of 47 specimens have been examined, most of which came from New Mexico, the others from Arizona and Texas. They were collected as follows: January, 7; May, 1; June, 2; July, 3; September, 13; October, 19, and November, 2. As with all other gallinaceous birds, more or less mineral matter is swallowed, usually small pieces of quartz. The food consisted of animal matter, 29.6 per cent, and vegetable matter, 70.4 per cent.

The food of the cotton top differs from that of all other American quails in that it contains a large proportion of insects. These comprise no less than 29.03 per cent of its food, a percentage almost twice as great as that of the bobwhite, although if more stomachs of the present species had been available for examination the ratio might have been different. However, the important fact is established that this bird is a large consumer of insects, instead of being, like most other western quail, practically graminivorous. Of the insect food, grasshoppers comprise 15.86 per cent; beetles, 10.43 per cent, and miscellaneous insects, largely ants, 3.27 per cent. A few spiders also are taken, but they constitute only 0.03 per cent of the food for the year. The beetles are in the larval as well as the adult forms. The family of ground beetles (*Carabidæ*), a favorite one with terrestrial birds, is well represented. A single beetle with a featherlike antenna, of the family *Pyrochroidæ*, had been eaten. Some longicorn beetles and plant-eating scarabæid beetles also were eaten. A bird collected in

[a] The name of the species is used here to include both the typical scaled quail (*Callipepla squamata*) and the more restricted chestnut-bellied quail of southern Texas (*C. s. castanogastris*).

[b] Life Hist. N. A. Birds [I], pp. 18–20, 1892.

June had consumed 44 of the latter beetles, which were leaf chafers, apparently closely related to the genus *Serica*. The scaled quail destroys also weevils, such as the clover weevil, *Sitones*, and certain species of the family *Otiorhynchidæ*, or scarred snout beetles. It takes also leaf beetles, the very injurious twelve-spotted cucumber beetle (*Diabrotica 12-punctata*). Further studies of the beetle food undoubtedly will disclose a large number of pests. The bird will probably be found to be a useful consumer also of grasshoppers, since a third of its September food consisted of them. Their remains were so fragmentary, however, that identification of species was unsatisfactory. In one case a member of the genus *Trimerotropis* was recognized. Ants had been eaten by 15 of the 47 birds examined. The other miscellaneous insects included small bugs (*Heteroptera*) and the chrysalis of a fly. One of the queerest objects found by the writer in birds' stomachs is the 'ground pearl' (*Margarodes*), several hundred of which were contained in the stomach of a cotton top shot at Roswell, N. Mex., June 17, 1899. They are lustrous and look like pearls, but are merely scale insects that feed on the roots of plants.

Vegetable matter furnished 70 per cent of the food of the scaled quail. Grain contributed 0.57 per cent; seeds, mostly weed seeds, 52.85 per cent; fruit, 12.65 per cent, and leaves and other green tissue, 4.33 per cent. The species resembles the ruffed grouse in its habit of feeding on green leaves and tender shoots. It feeds upon budded twigs, but more often limits its choice to chlorophyll-bearing tissue, often picking green seed pods of various plants. Like domestic fowls, it eats grass blades. Fruit was eaten by only 6 of the 47 birds, and none was taken from cultivated varieties. As might be expected from inhabitants of arid plains, these birds like the fruit of cacti, and have been found feeding on the prickly pear (*Opuntia lindheimeri*). The fruit of *Ibervillea lindheimeri* also is eaten. The blue berries of *Adelia angustifolia*, which furnish many desert birds and mammals with food, are often eaten by the scaled quail. Different kinds of *Rubus* fruits are relished, and the berries of *Koeberlinia spinosa* and *Momisia pallida* also are eaten. The fruit and succulent parts of plants no doubt serve in part in the parched desert as a substitute for water.

Seeds of various plants form a little more than half of the food. Legumes furnish 21.84 per cent, the mesquite (*Prosopis juliflora*), a staple with both man and beast, being utilized, as are the seeds of mimosa (*M. biuncifera*), besides various cassias and lupines. Seeds of vetch (*Vicia* sp.) are a favorite food, and *Morongia roemeriana* is eaten. The bird likes seeds of *Medicago*, and at times will eat clover seeds. Miscellaneous weed seeds yield 31.01 per cent of the annual food. Nearly half of these are seeds of bindweed (*Convolvulus* sp.),

an abundant and troublesome weed in the South, where it often throttles other plants. The following miscellaneous seeds were found among their food:

Thistle (*Carduus* sp.).
Wild sunflower (*Helianthus annuus*).
Coreopsis (*Coreopsis coronaria*).
Aster (*Aster* sp.).
Chamomile (*Anthemis* sp.).
Pigweed (*Amaranthus* sp.).
Gromwell (*Lithospermum* sp.).
Borage (*Amsinckia* sp.).
Mallow (*Malva rotundifolia*).
Turkey mullein (*Croton setigerus*).
Croton (*Croton texensis*).
Alfilaria (*Erodium cicutarium*).
Spurge (*Euphorbia* sp.).

Grass seeds have not yet been found in quantity in the crop of the species, but panicum seeds have been recognized.

In summing up the economic status of the scaled quail it should be noted that although the bird is a desert species, it comes into more or less direct relation with agriculture, sometimes feeding upon cultivated land and about farm buildings. Moreover, half of its food consists of the seeds of weeds. Lastly, it is highly insectivorous, fully one-fourth of its food consisting of insects.

MEARNS QUAIL.

(*Cyrtonyx montezumæ mearnsi.*[a])

The pervading colors of the male Mearns quail are black, white, and chestnut. Its thick speckles of white and its peculiar shape suggest a miniature guinea hen. The species is found on the table-lands of Mexico from the City of Mexico north to western Texas, New Mexico, and Arizona, but the bird considered here is limited to the northern part of this range.

It is a confiding bird and either from excess of curiosity or from stupidity has been known to remain on the ground to be killed by a stick. From this lack of suspicion it has received the name 'fool quail.' It affords the sportsman with a dog much better shooting than its more erratic crested relatives. Grassy or bushy cover is more necessary to this bird than to the scaled quail or Gambel quail. Unlike the latter species, it does not pack, though it is more or less migratory. Its nesting habits are not well known. Bendire describes a nest found in Kinney County, Tex., June 22, 1890. It was placed in a depression of the ground, and contained 10 eggs.

FOOD HABITS.

The food habits of the Mearns quail are not well known. The Biological Survey has examined the contents of 9 crops and stom-

[a] The typical Massena quail (*Cyrtonyx montezumæ*) is a bird of the mountains about the Mexican table-land, and gives way to the paler Mearns quail (*C. m. mearnsi*) in northern Mexico and the southwestern United States.

achs, secured in Texas and New Mexico during August and November. Two of the birds were killed in a patch of cactus. They contained seeds and spines from the prickly pear, acacia, and other seeds, grass blades, and a trace of insects—weevils and other beetles—besides a large quantity of coarse sand and iron ore. The other 7 birds were shot in August. Two had their crops filled with the bulbs of a lily. The others also had eaten lily bulbs, which in the 5 birds made three-fourths of the food. The other food was prickly pear fruit, seeds of legumes and spurges, and such insects as weevils, smooth caterpillars, hairy caterpillars, bugs, crickets, and grasshoppers. Cassin states that the contents of the crop of a specimen sent him from Texas by Captain French "consisted exclusively of fragments of insects, pronounced by Doctor Leconte to be principally grasshoppers and a specimen of *Spectrum*."[a] According to Baird, Brewer, and Ridgway, the Mearns quail appeared quite at home in cultivated fields and stubble of the ranches.[b] Away from civilization it prefers districts covered with open forest, with alternate areas of grass and scattered bushy undergrowth, or hillsides covered with grass and bushes. Its habits vary considerably with the locality. Bendire records that the species lives in rocky ravines and arroyos, but quickly adapts itself to ranch conditions and may be seen running about to gather kernels of scattered grain. He says also that it is fond of acorns, mountain laurel, arbutus, cedar, and other berries, and notes that its large, strong feet are well suited to unearthing the bulbs on which it feeds. He found holes 2 inches deep which it had dug for this purpose. These quail often come out into mountain roads to search for scattered grain and to dust themselves. As they are readily tamed, they could doubtless be successfully introduced into other regions.

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[a] Illustration of Birds of California, Texas, etc., p. 25, 1856.

[b] Hist. N. Am. Birds, III, p. 492, 1874.

INDEX.

	Page.
Animal food of bobwhite	45
Beetles eaten by bobwhite	38–42
Bobwhite	9–46
animal food	45
as an ally of the farmer	14
as an article of food	16
as an asset of the farm	15
as an object of sport	16
breeding habits	11
call notes	10
decrease	18
esthetic value	17
food habits	27–46
general habits	13
legislation regarding	19
preservation and propagation	20–26
wintering	23–26
Breeding habits	11–12
Buds as food of bobwhite	37
Bugs eaten by bobwhite	42
California quail	47–56
food habits	49
California mountain quail	8
valley quail	8
Callipepla squamata	61–63
Caterpillars eaten by bobwhite	44
Colinus ridgwayi	46
virginianus	9
Cyrtonyx montezumæ mearnsi	63
Decrease of bobwhite	18–19
Food habits of California quail	46
Gambel quail	57
Mearns quail	62
mountain quail	59, 60
scaled quail	61–63
Food of young bobwhite	45
California quail	55
Fool quail	8
Fruit as food of bobwhite	35–37
eaten by California quail	50
Gambel quail	8, 56–58
food habits	57, 58
Grain eaten by California quail	51
as food of bobwhite	28–31
Grasshoppers eaten by bobwhite	43, 44
Ground beetles eaten by bobwhite	38, 41
Insect food of California quail	49
Insects as food of bobwhite	37
Leaf-eating beetles eaten by bobwhite	39, 41
Leaves as food of bobwhite	37
eaten by California quail	52
Legislation in behalf of bobwhite	19–20

Page.
Lophortyx californica 47–56
vallicola 47–56
gambeli 56–58
Masked bobwhite 46
Mast as food of bobwhite 35
Mearns quail 8, 63
food habits 63
Miscellaneous animal food of bobwhite 45
Mountain quail 58–60
food habits 58–60
Oreortyx pictus 58–60
plumiferus 58–60
Pine seeds, food of bobwhite 35
Scaled quail 61–63
food habits 61–63
Vegetable food of California quail 50
Weed seeds as food of bobwhite 31–35
eaten by California quail 52
Weevils eaten by bobwhite 40, 41

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RUFFED GROUSE (BONASA UMBELLUS).

U. S. DEPARTMENT OF AGRICULTURE

BIOLOGICAL SURVEY—BULLETIN No. 24

C. HART MERRIAM, *Chief*

THE GROUSE AND WILD TURKEYS OF THE UNITED STATES, AND THEIR ECONOMIC VALUE

BY

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WASHINGTON

GOVERNMENT PRINTING OFFICE

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BIOLOGICAL SURVEY,
Washington, D. C., July 15, 1905.

SIR: I have the honor to transmit for publication as Bulletin 24 of the Biological Survey a report on the Grouse and Wild Turkeys of the United States, by Sylvester D. Judd. From the earliest settlement of the country to the present time these game birds have been of great economic consequence. Their value as food was early recognized, and they played an important rôle by furnishing the pioneers with no small part of their fare. When found by the Spaniards domesticated among the Indians of Mexico, the importance of the turkey was at once perceived, and the bird was soon carried all over the world. It is only in comparatively recent times, however, that the economic value of grouse and turkeys as insect destroyers has been recognized. The results of the present investigations should lead to a wider knowledge of the essential part these birds play in checking the increase of noxious weeds and insects and the importance of preserving them and of increasing their numbers.

Respectfully,

C. HART MERRIAM,
Chief, Biological Survey.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
The prairie hen (*Tympanuchus americanus*)	10
Preservation and propagation	11
Food habits	13
Insect food	14
Vegetable food	15
Food of the young	18
The heath hen (*Tympanuchus cupido*)	18
The lesser prairie hen (*Tympanuchus pallidicinctus*)	19
The sharp-tailed grouse (*Pediœcetes phasianellus*)	20
Food habits	21
Insect food	21
Vegetable food	22
The sage grouse (*Centrocercus urophasianus*)	23
Food habits	24
The ruffed grouse (*Bonasa umbellus*)	25
Preservation and propagation	28
Food habits	29
Insect food	29
Vegetable food	31
Food of the young	38
The spruce grouse (*Canachites canadensis*)	38
Food habits	39
The Franklin grouse (*Canachites franklini*)	40
The dusky grouse (*Dendragapus obscurus*)	41
Food habits	42
Vegetable food	42
The willow ptarmigan (*Lagopus lagopus*)	44
Food habits	45
The rock ptarmigan (*Lagopus rupestris*)	46
Food habits	46
The white-tailed ptarmigan (*Lagopus leucurus*)	47
Food habits	47
The wild turkey (*Meleagris gallopavo*)	48
Food habits	49

ILLUSTRATIONS.

PLATES.

		Page.
Plate I.	Ruffed grouse (*Bonasa umbellus*)	Frontispiece.
II.	Sage grouse (*Centrocercus urophasianus*)	24

GROUSE AND WILD TURKEYS OF THE UNITED STATES, AND THEIR ECONOMIC VALUE.

INTRODUCTION.

From the early settlement of America until the present day the size, toothsome qualities, and handsome appearance of the grouse and wild turkeys have given them a place among the most widely known and appreciated of our native birds. Throughout the conquest of the continent they served to eke out the scanty larder of the pioneer, and under the changed conditions of more recent times have taken an established place among the most prized luxuries of the table. Their habits are interesting alike to the country boy and the city sportsman, and both share in the keen pleasure of their pursuit. Their presence on the farm or in woodland is directly beneficial, owing to their destruction of harmful insects.

Twelve species of grouse occur within the limits of the United States, including Alaska. They inhabit the most varied country, from the rich prairies of the Mississippi Valley, through the heavily forested areas of the Eastern and Northern States, to above timber line on the desolate summits of mountain ranges and over dreary wastes of arctic tundra. While less beautifully marked than some of the quails, all the grouse are adorned with pleasing colors, and the males of the two species, the prairie hen and ruffed grouse, wear curiously shaped ornamental tufts of feathers on the sides of the neck. Some species have sacs on the neck, which they inflate to make the love notes more sonorous. The males of several species have over the eyes fleshy combs that are concealed by the feathers except in the mating season, when they become brightly colored and are erected to form conspicuous and attractive ornaments. These combs are especially noticeable in both the dusky grouse and the ptarmigans.

The grouse may be arranged in three groups according to the kind of country they occupy. The group of the open plains or of regions covered with a growth of scrubby bushes includes the prairie hens of the western prairies, from Manitoba south to Texas and Louisiana; the lesser prairie hen of the Southwest; the heath hen, once of the Eastern States, from Massachusetts to Virginia, now limited to Marthas Vineyard; the sharp-tailed grouse of the Northwest; and the

sage cock of the sagebrush deserts of the Great Basin, a fine bird, nearly as large as a turkey.

Next are the species of the forested regions. The most notable of these, the well-known ruffed grouse, occurs in wooded areas all through the eastern and northern parts of the country from Maine to northern California, and north to Alaska. Within this wide range it varies sufficiently in color to be separable into four forms. The Canada grouse, which also has been separated into several local forms, has nearly the same range in the north as the ruffed grouse, but does not extend so far south. The Franklin grouse, closely related to the spruce grouse, occurs only from the Rocky Mountains west, and north to Alaska. The blue, or dusky, grouse, called 'fool-hen' in the Rocky Mountains, also varies in color in parts of its range so that it has been divided into several not strikingly different local forms. It is the largest of the forest-loving species and is found only in the wooded mountain areas of the West, from the Rocky Mountains and Sierra Nevada north to Alaska. The forest-inhabiting grouse are rarely near neighbors of man, and hence are of less consequence to agriculture than those of the open country.

The last group of grouse comprises the ptarmigans, which live above timber line on the high summits of the Rocky Mountains and thence north over suitable country to the arctic tundras of Alaska. The ptarmigans are remarkable for the way in which they meet the seasonal conditions of their arctic home by changing the grays and browns of their summer dress for the snowy-white of their winter one. The willow grouse, or common white ptarmigan, a circumpolar bird, is common on the tundras of Alaska and British America. With it occurs the rock ptarmigan, which is rather more of a hill bird, and which is represented on the Aleutian chain by four island forms that differ slightly in color from it and from one another. The white-tailed ptarmigan occurs above timber line in the Rocky Mountains from the northern part of New Mexico to British Columbia and Alaska. Owing to their arctic or subarctic homes the ptarmigans have practically no relations with agriculture. They are resident throughout the year and abound in many parts of Alaska, where they have long been prized as food by the natives, and now are a welcome addition to the fare of the more recent population, though, as a rule, their flesh is dry and without much flavor.

The common tame turkey is a descendant of birds taken to Europe from Mexico by the Spaniards early in the sixteenth century. The wild turkeys of the United States originally occupied a large area extending from the coast of Massachusetts west to Colorado and south to Florida and the Mexican border. While they are of the same species as the Mexican bird, they have been modified by the varying conditions of their environment into four forms, distinguished

by differences in color. The best known of these is the common wild turkey of the Mississippi Valley and the Eastern States. The others are the Florida wild turkey, the Rio Grande turkey, and the Merriam turkey of the southern Rocky Mountains from Colorado south through New Mexico and Arizona. These birds differ in color to a certain extent, but have a close general resemblance. Owing to their size and the value set on their flesh, wild turkeys have been hunted so persistently that they have been exterminated over much of their former range and have become the shyest of our game birds. There are remarkable exceptions to this rule, however, as their persistence up to the present day in parts of Virginia and Maryland, within a few miles of Washington City. This ability to maintain a foothold in long-settled parts of their old territory suggests the feasibility of restocking parts of their former range. In pioneer days they were often destructive to cornfields, and in remote places they still raid grainfields, but the damage is insignificant.

Unfortunately a number of our game birds are now gone or are fast disappearing from their former haunts. An awakening appreciation of the real value of some of the species and of the evident danger of their extermination is evinced by protective laws that have been enacted in recent years throughout the country. These laws are mainly the outcome of a realization of the value of the birds from the sportsman's point of view. The investigations upon which the present report is based show that the farmer has a vastly greater interest at stake in the increase and protection of some of these birds, notably the bobwhite, than has the sportsman. In view of the decrease of both bobwhites and prairie hens it is important to know that there is every probability that proper efforts to rear these birds for restocking purposes will be successful. The numbers of bobwhite may be readily increased by careful protection, but the heath hen is already extinct in the Eastern States, and the prairie hen is nearly or quite gone from large areas in the West where it was numerous a few years ago. The restocking of suitable places in the former range of the prairie hen and even in the former range of the heath hen in the coast region of Virginia and Maryland appears to be quite practicable. The significance of an experiment made by Audubon many years ago at Henderson, Ky., is of special interest in this connection. In the fall he secured 60 prairie hens and, clipping their wings, turned them loose in his garden and orchard which contained about 4 acres. The birds quickly became tame and "walked about the garden like so many tame fowls, mingling occasionally with the domestic poultry." The importance of the prairie hen as a destroyer of weeds and insects has been demonstrated, and its value as a food and game bird is well known. As the bird possesses such

6568—No. 24—05 M——2

good qualities and as proper efforts for its reintroduction into parts of its former range will almost certainly be successful, it is hoped that the undertaking will not long be delayed. It is unquestionable that the presence of this bird will add appreciably to the value of any farm.

THE PRAIRIE HEN.

(*Tympanuchus americanus.*)

The prairie hen, or 'prairie chicken,' inhabits the western prairies from Manitoba to southern Texas and Louisiana and from Ohio to Nebraska. The birds of southern Texas and Louisiana [a] are smaller and darker than the common bird. This big grouse, resembling a brownish-gray hen, adds animation to the western prairies and is as characteristic of them as the mockingbird is of the South. In the nuptial season the birds assemble every morning at daybreak on little hillocks on the plains, and the cocks strut about with wings drooping, tail spread, and the large orange-colored sacs on the sides of the neck fully inflated. At intervals they lower their heads and emit a singular booming love note that can be heard more than a mile, and is one of the most striking bird notes in the general spring chorus. The rivalry of the males at these gatherings often leads to fierce fights. Finally all find partners, separate into pairs, and make nests in grass-lined depressions among standing grass or similar shelter, where about a dozen eggs are laid to a clutch. Generally only one brood is raised in a season. The young, like those of other gallinaceous birds, leave the nest as soon as they are hatched and run about with the hen in search of food. In summer prairie hens roost on the ground in a family covey, as does the bobwhite, but in winter, in many sections, they roost in trees. In the fall several coveys congregate in a pack, after the fashion of ptarmigans and crested quail. Prof. F. E. L. Beal informs the writer that at Ames, Iowa, during the early eighties, he frequently found packs numbering as many as a thousand birds, and that they habitually roosted in the long grass beside sloughs. The prairie hen is migratory in the northern part of its range, and to a certain extent farther south also. The well-known authority on migration, Prof. W. W. Cooke, says: [b]

> In November and December large flocks of prairie chickens come from northern Iowa and southern Minnesota to settle for the winter in northern Missouri and southern Iowa. This migration varies in bulk with the severity of the winter.

From a gastronomic point of view the prairie hen deserves high praise; it is larger than the ruffed grouse, sometimes weighing 3 pounds, and has a delicious flavor. The flesh of young birds is light-colored, of old ones dark. The estimation in which the bird is held

[a] *Tympanuchus americanus attwateri* (Bendire).

[b] Bul. 2, Div. Econ. Ornith., Dept. Agri., p. 105, 1888.

may be realized from the fact that in 1902 the supply at from $3 to $5 a brace nowhere met the demand. Years ago prairie chickens were shipped east by carloads, but to-day scarcity of birds and a commendable stringency of laws practically preclude shipments.

Many sportsmen declare that there is no better sport than 'chicken' shooting. The bird unquestionably is one of the noblest of game birds. Though in speed of flight it by no means equals the ruffed grouse or the bobwhite, it furnishes fine sport when hunted with dogs. Early in the season, in suitable cover, it lies to a dog like a stone. So reluctant occasionally is it to fly that it can hardly be put up, and Professor Cooke informs the writer that several times while hunting in northern Minnesota he saw a pointing dog jump and catch a three-fourths grown prairie hen. Late in the fall, however, when gathered in large packs, they do not lie well.

Early in the season—that is, during the last two weeks of August and the first part of September—the prairie hen affords a better test of a dog's ability to hunt fast and to range out a mile or more from the gun than does the bobwhite. It is for this reason that field trials on 'chickens' are always well patronized, and the dogs that win are highly valued. So highly esteemed is the prairie chicken as the quarry of 'racing' dogs that abundant means for the restocking of suitable places with the species is likely to be forthcoming from field-trial patrons. The ideal conditions for 'chicken' shooting are realized in a fenceless country, where it is possible for the hunter to drive, while the dogs range from a quarter of a mile to a mile away from the wagon. As soon as they point game the sportsman hurries up and shoots. The driver 'marks down' the birds that escape and perhaps fly half a mile before alighting. Then the wagon advances to where they dropped, and shooting is again in order. In some parts of the country the sport stops at 10 or 11 o'clock in the morning, because of the intense heat during the middle of the day, when the birds are resting in places difficult of access, and is not resumed before 3 or 4 o'clock in the afternoon.

PRESERVATION AND PROPAGATION.

The prairie hen deserves well of man. It is beneficial to agriculture, is one of the best table delicacies, and its booming call is the dominant spring note of the plains, as the bird is their most characteristic resident. Furthermore, the number of entries to the yearly field trials on 'chickens' speak for it as an object of sport. In view of all the good qualities of the bird, the causes of its diminished numbers should be sought, and adequate means applied to preserve it from extinction.

At the beginning of the nineteenth century the prairie hen was

extremely abundant throughout Ohio and Kentucky. It is now rare in both States. A part of the ground it has lost in the East it has gained by a westward and northward movement. It has followed the grain fields of the pioneers of the plains, and with the extension of grain culture into Minnesota and Manitoba it has become plentiful there. According to Doctor Hatch, it was by no means common when the white man first came to Minnesota, and he says that in Illinois as late as 1836 a hunter was extremely lucky if he could bag a dozen in a day. Some years later, with much less effort, one could have shot 50 in a day, and there were records of 100 to a single gun.[a]

The former status of the bird in the East is well indicated by Audubon's classic observations at Henderson, Ky., in 1810. Audubon says:[b]

> In those days during the winter the Grous would enter the farm-yard and feed with the poultry, alight on the houses, or walk in the very streets of the villages. I recollect having caught several in a stable at Henderson, where they had followed some Wild Turkeys. In the course of the same winter, a friend of mine, who was fond of practicing rifle shooting, killed upwards of forty in one morning, but picked none of them up, so satiated with Grous was he, as well as every member of his family. My own servants preferred the fattest flitch of bacon to their flesh, and not unfrequently laid them aside as unfit for cooking. * * * They could not have been sold at more than one cent apiece. * * * So rare have they become in the markets of Philadelphia, New York, and Boston, that they sell at from five to ten dollars the pair.

So far as the sportsman is concerned, the prairie hen is now extinct in Kentucky, and nowhere is the royal game bird even approximately so abundant as it formerly was in that State. There is little good chicken shooting east of the Mississippi. The best now to be had is in Kansas, Nebraska, Minnesota, the Dakotas, and Manitoba. Fortunately many people are actively interested in the protection and preservation of the prairie hen and excellent laws in its behalf already exist. There is a constantly growing sentiment in favor of nonresident hunting licenses and a legal limit to the day's bag, while some States afford the bird absolute protection for a period of years,[c] and their example should be followed wherever it is growing scarce. The passage of nonexport laws in most of the States has been productive of much good. These State laws have been made effective by a recent Federal law—the Lacey Act—which prohibits interstate commerce in game killed in violation of local laws. Through its operation the sale of the prairie hen was virtually stopped in 1902 and 1903 in all the large cities of the East. Absolute enforcement of this law and successful prohibition of local sales must be effected before

[a] Birds of Minnesota, p. 163, 1892.

[b] Ornith. Biog. II, p. 491, 1835.

[c] Illinois, Louisiana, and Oregon protect prairie hens until 1909, and Michigan and the Province of Ontario until 1910.

the safety of the bird is assured. The laws relating to the close season have been greatly improved, but in some States the open season (four months in Oklahoma and South Dakota) is still too long.

The preservation of the prairie hen is far more difficult than that of the bobwhite. The bobwhite is more prolific and does not require so extensive a range. Moreover, it is swifter of wing and habitually dives into the woods to escape the hunter. Before the hammerless gun and the wide-ranging bird dog the grouse of the open prairie falls an easy victim. It has to contend also with the trapper, besides predatory birds, reptiles, and mammals. Its most deadly enemy, however, is the prairie fire in spring, which destroys every nest within its sweep. E. W. Nelson informs the writer that in the early seventies in northwestern Illinois the farmers in many places burned the prairies in spring after the prairie hens nested, and often gathered for household use large numbers of the eggs thus exposed. Were it possible for stockmen to burn the grass a little earlier it would result in the saving of thousands of birds.

The prairie hen has the advantage, however, of yielding more readily to domestication than the bobwhite, and strong efforts should be made to establish preserves of domesticated birds for restocking country where the species is extinct. Successful enterprises of this kind would be profitable. That such domestication is possible and even feasible, the appended quotation from Audubon implies:[a]

> The Pinnated Grous is easily tamed, and easily kept. It also breeds in confinement, and I have often felt surprised that it has not been fairly domesticated. While at Henderson, I purchased sixty alive, that were expressly caught for me within twelve miles of that village, and brought in a bag laid across the back of a horse. I cut the tips of their wings, and turned them loose in a garden and orchard about four acres in extent. Within a week they became tame enough to allow me to approach them without their being frightened. * * * In the course of the winter they became so gentle as to feed from the hand of my wife, and walked about the garden like so many tame fowls, mingling occasionally with the domestic poultry. * * * When spring returned they strutted, 'tooted,' and fought, as if in the wilds where they had received their birth. Many laid eggs, and a good number of young ones made their appearance.

There is great probability of success in the restocking of much of the former range of the prairie hen if undertaken in the proper way and properly sustained by adequate protective laws. Successful results would materially add to the assets of every farm.

FOOD HABITS.

For the purposes of this report the contents of 71 stomachs of prairie hens have been examined. Fortunately this material represents not only the shooting season, but all other months except July. Most of the stomachs came from the Dakotas, Minnesota, Iowa, Wis-

[a] Ornith. Biog. II, p. 495, 1835.

consin, Nebraska, and Texas; Illinois and Ontario furnished the rest. The food consisted of 14.11 percent animal matter and 85.89 percent vegetable matter. The former was insects; the latter seeds, fruit, grain, leaves, flowers, and bud twigs.

Insect Food.

The insect food included 12.78 percent of grasshoppers, 0.48 percent of beetles, 0.39 percent of bugs, 0.12 percent of ants and other Hymenoptera, 0.29 percent of other insects, and 0.05 percent of spiders. The ruffed grouse takes about one-sixth less and the bobwhite about one-third more of insects than the prairie hen. Although the bobwhite destroys injurious grasshoppers, the relative proportions of grasshoppers and beetles consumed by it and by the prairie hen are notably different. In the food of the bobwhite the grasshoppers are to the beetles as 3.71 to 6.92; with the prairie hen the ratio stands as 12.78 to 0.48. Indeed, grasshoppers constitute the bulk of the prairie hen's animal diet, the reason being probably that on the prairies the grasshoppers vastly outnumber all other sizable insects. For a gallinaceous bird the prairie hen is highly insectivorous from May to October, inclusive, insects constituting one-third of the fare of the specimens shot during this period. The species is particularly valuable as an enemy of the Rocky Mountain locust. During an invasion by this pest in Nebraska, 16 out of 20 grouse killed by Prof. Samuel Aughey from May to October, inclusive, had eaten 866 locusts—a creditable performance, economically rated. Some ornithologists believe that the diminution in the number of prairie hens is in a measure responsible for the ravages of certain insects. Farmers who know these facts must regret the extinction of the bird in States where it once thrived, and they may well support measures for reintroducing and protecting it.

Almost every kind of grasshopper and locust appears to be acceptable to the prairie hen. In the following list are named the species of short-horned grasshoppers identified in its food:

Opomala sp.
Mermiria alacris.
Philibostroma quadrimaculatum.
Leptysma sp.
Psolœssa sp.
Agenceotettix scudderi.
Spharagemon sp.
Schistocerca americana.
Cordillacris occipitalis.
Stenobothrus curtipennis.
Melanoplus femur-rubrum.
Melanoplus atlanis.
Melanoplus bivittatus.

The prairie hen eats also long-horned grasshoppers (*Xiphidium* sp., *Conocephalus* sp., and *Orchelimum* sp.) and crickets (*Gryllus* sp.) and tree crickets (*Œcanthus* sp.).

In its beetle diet the prairie hen makes up in variety what it lacks in quantity. Unlike our common small passerine birds, but like our other gallinaceous birds, it feeds on the harmful leaf beetles. It

destroys also the potato beetle (*Leptinotarsa decemlineata*), in both adult and larval stages, and the injurious 12-spotted cucumber beetle (*Diabrotica 12-punctata*). The stomach of a bird collected by H. P. Attwater, November 7, 1893, in Aransas County, Tex., contained 16 of these latter insects. Among other leaf-eating beetles eaten may be mentioned *Chrysomela pulchra*, *Chrysomela suturalis*, *Disonycha quinquevittata*, *Monoxia puncticollis*, and *Graphops pubescens*. The injurious May beetles (*Lachnosterna* sp.) also are destroyed, as well as weevils (*Thecesternus humeralis* and other species). Like many other birds, the prairie hen is partial to ground beetles. It has been known to take such kinds as *Anisodactylus rusticus*, *Agonoderus pallipes*, *Amara* sp., and *Chlænius* sp. It probably feeds also on the different abundant species of *Harpalus*. Ladybirds are at times destroyed, as was attested by remains of *Hippodamia convergens* contained in one stomach.

Miscellaneous insects are eaten in small numbers, but are interesting because they include a number of the worst insect foes, such as the cotton worm (*Alabama argillacea*),[a] the army worm (*Heliophila unipuncta*), several species of cutworms, the yellow bear caterpillar (*Diacrisia virginica*), cankerworms (*Geometridæ*), the Angoumois grain moth (*Sitotroga cerealella*), and the chinch bug (*Blissus leucopterus*). The bird's habits of eating chinch bugs has been reported by B. F. Gault, of Chicago, and Prof. F. M. Webster, of the Bureau of Entomology. Other bugs, including stink bugs (*Euschistus* sp.) and the tree hoppers (*Stictocephalus* sp.) make part of the food. In addition to ants, such as *Formica exsectoides*, the prairie hen occasionally eats other Hymenoptera, including *Tiphia inornata* and gall insects contained in the galls of Cynipidæ. In its liking for galls and their contents the bird resembles the ruffed grouse and the British pheasant.

Further study of the food habits of the prairie hen will unquestionably add largely to the foregoing enumeration of insects, but our present knowledge, incomplete as it is, shows the general character of its insect food, and establishes the value of the species as a destroyer of insect pests.

Vegetable Food.

From October to April, inclusive, the prairie hen takes little but vegetable food. This element amounts to 85.89 percent for the year. Fruit constitutes 11.79 percent; leaves, flowers, and shoots, 25.09 percent; seeds, 14.87 percent; grain, 31.06 percent, and miscellaneous vegetable material, 3.08 percent.

Like the bobwhite and the ruffed grouse, the prairie hen is fond of rose hips, and the abundant roses of the prairie yield 11.01 percent

[a] Fourth Rep. U. S. Ent. Commission, p. 88, 1885.

of its food. This fact perhaps may be a useful hint to anyone who attempts to introduce the bird or to improve its environment. The other fruit found was of little importance—merely 0.78 percent. It was made up of domestic cherries, woodbine berries, sumac, poison ivy, huckleberries, strawberries, partridge berries, mistletoe, wild grapes, the berries of *Solanum* and *Symphoricarpus*, and cornel (*Cornus asperifolia*). Of the frugivorous habits of the prairie hen Audubon writes:[a]

> In the western country, at the approach of winter, these birds frequent the tops of the sumach bushes, to feed on their seeds, often in such numbers that I have seen the bushes bent by their weight.

It is important to note that often when deep snow causes scarcity of other supplies the sumac affords both the prairie hen and the bobwhite abundant food. As with the insect food, further investigation undoubtedly will extend the fruit list.

The prairie hen eats a much smaller proportion of seeds, with the exception of grain, than the bobwhite, and in this respect is less useful than the latter bird. It is, however, a better weeder than any other grouse, and its services in this particular are worthy of consideration. As before stated, seeds make 14.87 percent of the annual diet. Of these, grass seeds form 1.03 percent; seeds of various polygonums, 8.49 percent, and miscellaneous weed seeds, 5.35 percent. When the nature of the prairie hen's habitat is recalled it seems strange that the percentage of grass seed is so small. The bobwhite, in contrast, takes 9.46 percent of grass seed. Like the bobwhite and other granivorous birds, the prairie hen often eats the seeds of the various species of panicums, the paspalums, and pigeon grass (*Chætochloa viridis*).

The seeds of different polygonums, or smartweeds, play an important part in the economy of the prairie hen. They form 8.49 percent of the food. These plants grow profusely where illy drained regions of the plains are under water for a few months in the year. Black bindweed (*Polygonum convolvulus*) and smartweed (*Polygonum lapathifolium*), with the closely related dock (*Rumex crispus*), are included in the bill of fare. Of the 5.35 percent of remaining miscellaneous seeds, ragweed (*Ambrosia artemisiæfolia*) is the most important element, but is insignificant in amount when compared with the same element of the bobwhite's food. Other compositæ are eaten by the prairie hen—wild sunflower, coreopsis (*Coreopsis cardaminefolia*), and others. The prairie hen has a liking for legumes, reminding one again of the bobwhite. It selects two of the latter's favorites—cassia, and the hog peanut (*Falcata comosa*). It takes also the seeds of a closely related plant, the prairie mimosa (*Acuan*). It has been known to feed on seeds of water willow (*Dianthera* sp.), the yellow false garlic (*Nothoscordum bivale*),

[a] Ornith. Biog., II, p. 501, 1835.

blue-eyed grass (*Sisyrinchium graminoides*), shepherd's purse (*Bursa bursa-pastoris*), mercury seeds (*Acalypha* sp.), croton seeds (*Croton* sp.), and seeds of purslane (*Portulaca oleracea*), the seeded pods of the latter being plucked.

GRAIN.

As a grain eater the prairie hen heads the native gallinaceous birds. Everybody who has gone 'chicken' shooting knows how closely the bird is associated with stubble fields. The stomachs and crops examined in the investigation contained 31.06 percent of grain. The bobwhite, another busy stubble feeder, takes only 17.38 percent. The stomach of a grouse shot in June in Nebraska contained 100 kernels of corn and 500 grains of wheat. J. A. Loring, formerly of the Biological Survey, during December in Nebraska found prairie hens feeding in wheat stubble, about straw stacks, and along the edges of cornfields. Doctor Hatch, in writing of their granivorous habits, says:[a]

> The grain fields afforded both food and protection for them, until the farmers complained of them bitterly, but not half so bitterly as they did afterwards of the bird destroyers who ran over their broad acres of wheat, oats, and corn in the order of their ripening.

Buckwheat, barley, oats, and millet are relished, but corn appears to be the favorite cereal, amounting to 19.45 percent of the annual food. Other grain, principally wheat, was in the ratio of 11.61 percent. Amos W. Butler reports that in Indiana, during September, fields of ripening buckwheat are favorite feeding grounds.[b] There is reason to believe that sprouting grain is sometimes injured. Audubon speaks of such injury in Kentucky, where the bird was extremely abundant.[c]

Like other gallinaceous birds, the prairie hen likes mast, though naturally it obtains much less than the ruffed grouse. The stomach contents showed the beaked hazelnut (*Corylus rostrata*) and acorns, including, among others, those of the scrub oak (*Quercus nana*) and the scarlet oak (*Q. coccinea*). Like the ruffed grouse, it swallows acorns whole. A bird shot in Minnesota in March had bolted 28 scarlet-oak acorns.

LEAVES, FLOWERS, AND SHOOTS.

Like other grouse the prairie hen is an habitual browser, to the extent of 25.09 percent of its food. This is divided as follows: Twigs

[a] Birds of Minnesota, p. 163, 1892.
[b] Ann. Rept. Dept. Geol. Ind., 1897, p. 758.
[c] Ornith. Biog., II, p. 491, 1835.

or shoots, 0.55 percent; flowers, 9.34 percent, and leaves, 15.20 percent. This is only half the amount of similar food taken by the ruffed grouse. Naturally the prairie hen is much less given to budding than the ruffed grouse, but it has been known to pluck buds of poplar, elm, pine, apple, dwarf birch (*Betula glandulosa*), and black birch (*B. lenta*). "I have counted more than 50 on a single apple tree," writes Audubon,[a] "the buds of which they entirely destroyed in a few hours. * * * They were, in fact, looked upon with more abhorrence than the crows are at present in Massachusetts and Maine, on account of the mischief they committed among the fruit trees of the orchards during winter, when they fed on their buds, or while in the spring months, they picked up the grain in the fields." This mischief was due largely to the abundance of the birds, a condition never likely to return.

The prairie hen shows a marked taste for flowers. A delicate pink rosebud had been plucked by a bird shot at Omega, Nebr., in June. More than a thousand golden-rod heads were found in another. Additional composite flowers devoured were Amphiachyris (*Amphiachyris dracunculoides*), sweet balsam (*Gnaphalium obtusifolium*), and others. The flower and leaf buds of birch and apple also are taken. Small green ovaries of *Ruellia* and blue-eyed grass were noted in a few cases. These birds eat leaves, including those of the buttercup, everlasting (*Antennaria*), red and white clover, and the interesting water milfoil (*Myriophyllum*), often grown in goldfish globes.

Food of the Young.

The economic value of the prairie hen is due mainly to its destruction of weeds and harmful insects, the latter constituting almost the sole food of the downy chick. Unfortunately only two stomachs of young birds were to be had for examination. The chicks were recently hatched Texas prairie hens (*Tympanuchus americanus attwateri*). They had eaten 1 tree cricket, 5 undetermined caterpillars, 1 imago of the very destructive Angoumois grain moth, 1 leaf beetle (*Monoxia puncticollis*), and 19 12-spotted cucumber beetles (*Diabrotica 12-punctata*), which do not always confine themselves to cucumbers, but injure more than a dozen other cultivated plants.

THE HEATH HEN.

(*Tympanuchus cupido.*)

The heath hen, which, to casual view, appears like a small-sized prairie hen, inhabits the scrub oaks of the island of Marthas Vineyard, on the coast of Massachusetts. It was formerly abundant in

[a] Ornith. Biog., II, pp. 491 and 501, 1835.

Connecticut and the eastern parts of New York, New Jersey, Pennsylvania, and Virginia.

As no stomachs of this now rare bird were to be had for examination, we must depend on the work of other investigators for knowledge of its food habits. Audubon [a] quotes David Eckley as follows:

> The bayberry, which abounds in many parts of Martha's Vineyard, is the principal food of the Grous particularly such as grows on low bushes near the ground, and is easily reached by the birds. They also feed on the boxberry, or partridge berry, the highland and lowland cranberry, rosebuds, pine and alder buds, acorns, etc.

William Brewster in 1890 ascertained that, all told, there were probably only about 200 heath hens, and that they were confined to about 40 square miles of the island of Marthas Vineyard. In speaking of their habits, he says: [b]

> At all seasons the heath hens live almost exclusively in the oak woods, where the acorns furnish them abundant food, although, like our ruffed grouse, they occasionally, at early morning and just after sunset, venture out a little way in the open to pick up scattered grains of corn or to pluck a few clover leaves, of which they are extremely fond. They also wander to some extent over the scrub-oak plains, especially when blueberries are ripe and abundant. In winter, during long-continued snows, they sometimes approach buildings to feed upon the grain which the farmers throw out to them.

If this bird can be saved from extinction and introduced into many of the Eastern States, it will be much more likely to succeed, on account of its woodland habits and narrow range, than the prairie hen, which requires a more open country and usually does not take refuge in woods from its enemies. Experiments with the heath hen must be made soon, however, or it is likely to become extinct.

THE LESSER PRAIRIE HEN.

(Tympanuchus pallidicinctus.)

The lesser prairie hen is a smaller bird than the common species of the Mississippi Valley and is found from western Texas north to western Kansas. But little of its life history is known. It has been found breeding abundantly the first of June at Fort Cobb, Ind. T., and William Lloyd observed this grouse wintering in Concho and Tom Green counties, Tex. H. C. Oberholser, of the Biological Survey, found them common in August, 1901, in Wheeler County, Tex., where they frequented rolling plains overgrown with oak brush from 1 to 4 feet high. These oaks are evergreen, and the prairie hen feeds upon the buds and young shoots. At the time of Oberholser's visit the birds were in coveys of from

[a] Ornith. Biog., II, p. 500, 1835.

[b] Forest and Stream, XXXV, p. 188, 1890.

15 to 20, but, according to the people of that section, the prairie hens gather in flocks of hundreds in the late fall. At this season they are destructive to unthreshed wheat and oats, tearing off the surface of the stacks. In winter they visit cattle pens and corrals in search of food. During severe winters they are sometimes so numerous that they become a nuisance. Some idea may be had of their abundance during winter from the information secured by Oberholser that one man shipped 20,000 of them from this section in a single season.

THE SHARP-TAILED GROUSE.

(*Pediœcetes phasianellus.*)[a]

The sharp-tailed grouse is about the same size and has the general appearance of the prairie hen. Its range is wide, extending from Lake Michigan to northeastern California, and from northeastern New Mexico to Alaska. In the northern part of the Mississippi Valley its range overlaps that of the prairie hen, and mixed flocks are sometimes seen, but the 'spike tail' is seldom found in such large numbers as that species. It shows also much less adaptability to changed conditions and disappears more rapidly after the subjection of its range to agriculture. In regard to its curious courtship, Professor Macoun writes of the Columbian sharp-tailed grouse:[b]

> The males collect in large numbers on some hill about the end of April or beginning of May to have their annual dance, which they keep up for a month or six weeks. It is almost impossible to drive them away from one of their hills when they are dancing. One day about the middle of May, I shot into a dancing party, killing two, and wounding another, which flew a short distance. I went to get it, and before I got back to pick up the dead birds, the others were back dancing around them.

About a dozen eggs generally make a clutch, and but one brood is reared in a season. The eggs vary from buff to olive-brown and are usually lightly spotted with brown.

From two to three months after hatching, the young are full grown and afford quite as good if not better sport than the prairie hen. They lie well to the dog and usually rise with a noisy, clucking cry; after a short distance the flight changes to an alternation of rapid vibrations of the wings and gliding or sailing on stiffly outspread pinions. The flesh of the young, like that of young prairie hens, is

[a] The sharp-tailed grouse varies in different parts of its range, and has been divided into two geographic forms in addition to the typical bird. These are the Columbian sharp-tailed grouse (*Pediœcetes phasianellus columbianus*), occupying the western part of the bird's range in the United States, and the prairie sharp-tailed grouse (*Pediœcetes phasianellus campestris*) which covers the plains east of the Rocky Mountains.

[b] Cat. Can. Birds, pt. 1, p. 212, 1900.

light colored and deliciously flavored. After the birds begin to pack they afford little sport to the hunter.

The sharp-tailed grouse are partly migratory. In winter they take refuge in the highest trees, walking among the branches almost as nimbly as the ruffed grouse. Like the latter, the present species has a habit of plunging into the snow to spend the wintry night. It has many natural enemies in the winter, and in summer the golden eagle has been known to feed its young very largely upon its flesh. Its struggle for existence is unusually severe. Wherever it abounds, in accessible districts, it is pursued relentlessly by the sportsman; but where diminished to a certain point, as on its western and northern ranges, hunting it is largely abandoned. Probably some decades will pass, therefore, before it will be in danger of total extinction. As it does not readily accept civilization, it is not likely to become a popular bird in our growing game preserves, which each year become of greater economic importance.

FOOD HABITS.

The food habits of the sharp-tailed grouse have been studied in connection with the present paper by the examination of 43 stomachs. These were collected in every month of the year except January and March; most of them in Nebraska and the Northwest Territories, but some in Minnesota, North Dakota, and Manitoba. The investigations showed that animal matter (insects) formed only 10.19 per cent of the food, while vegetable matter (seeds, fruit, and 'browse') made 89.81 percent. If subsequent study proves that these figures apply generally to the species, the sharp-tailed grouse is to be classed among the birds most largely vegetarian.

INSECT FOOD.

The insect matter consists of bugs, 0.50 percent; grasshoppers, 4.62 percent; beetles, 2.86 percent, and miscellaneous insects, 2.21 percent in a total of 10.19 percent of the food. Vernon Bailey, of the Biological Survey, found that three birds shot by him in Idaho August 29 had eaten chiefly insects, including grasshoppers, small bugs, and small caterpillars. Baird, Brewer, and Ridgway state that the Columbian sharp-tailed grouse has been known to feed on caterpillars and other insects that have been scorched by prairie fires.[a]

The young of the sharp-tailed grouse, like those of other gallinaceous species, are highly insectivorous. A downy chick from 1 to 3 days old, collected on June 27, in Manitoba, by Ernest Thompson Seton, had eaten 95 percent of insects and 5 percent of wild straw-

[a] Hist. N. A. Birds, Land Birds, III, p. 439, 1874.

berries. The insect material consisted of a lepidopterous chrysalis and the remains of beetles and black ants (*Camponotus pennsylvanicus*). Another young bird, about 8 days old, taken by the same collector, had been exclusively insectivorous. It had eaten such beetles as weevils, ground beetles (*Harpalus herbivagus*), the lady-bird (*Anisosticta seriata*), and the click beetle (*Dolopius lateralis*), also 2 cutworms, 9 sawfly larvæ, such leaf hoppers as *Tettegonia* sp. and *Helochara communis*, and 1 leaf spider. The sharp-tailed grouse is fond of grasshoppers. Vernon Bailey shot 3 birds at Elk River, Minn., September 17, 1894, which had eaten, respectively, 7, 23, and 31 grasshoppers. The species is a destroyer also of the Rocky Mountain locust. Of 9 birds collected by Professor Aughey from May to October, inclusive, 6 had eaten 174 of these pests.[a] The bird eats also a few crickets and, like other gallinaceous game birds, devours the Colorado potato beetle (*Leptinotarsa decemlineata*). It has been known to feed on the bugs *Oncometopia lateralis* and *Oncometopia costalis*. The lack of sufficient material to determine exactly the bird's relation to insects is to be regretted, but enough is at hand to demonstrate the fact that its insect food is much like that of its relatives.

VEGETABLE FOOD.

The vegetable food of the sharp-tailed grouse, so far as ascertained in the laboratory, comprises weed seeds, 7.39 percent; grain, 20.50 percent; fruit, 27.68 percent; leaves, buds, and flowers, 31.07 percent, and miscellaneous vegetable food, 3.06 percent; making a total of 89.81 percent. The weed-seed element consists of the seeds of black bindweed (*Polygonum convolvulus*) and other polygonums, wild sunflower (*Helianthus* sp.), ragweed (*Ambrosia artemisiæfolia*), peppergrass (*Lepidium*), blue-eyed grass, sedge, and catchfly (*Silene antirrhina*). The seeds of a number of leguminous plants are eaten, including those of alfalfa. Like many other game birds, the species feeds on mast (largely acorns), including acorns of the scarlet oak (*Quercus coccinea*). Corn is eaten, but wheat is the favorite grain. It formed 17.21 percent of the food. A thousand kernels of wheat were sometimes found in one stomach.

The sharp-tailed grouse is a great browser. It makes 31.07 percent of its food of leaves, buds, and flowers. Ernest Thompson Seton found it eating the buds of willow and birch. It feeds on the leaves of cottonwood, alder, blueberry, juniper, and larch; also leaves of quillwort (*Isoetes*), vetch, dandelion, grass, and rush (*Juncus*). Hearne says that in winter it eats the tops of the dwarf birch and the buds of poplars. Flowers form 19.90 percent of its diet, the species

[a] First Rep. U. S. Entom. Comm., Append. II, p. 47, 1877 (1878).

leading all other birds in this respect. A half pint of the showy, bluish blossoms of the pasque flower (*Pulsatilla hirsutissima*) which brightens the western prairie are often taken at a meal, and those of the dandelion also are eaten. Inflorescence of grasses, alder, willow, maple, and canoe birch are plucked along with leaf buds.

Like the prairie hen and the ruffed grouse, the sharp-tailed grouse is frugivorous, and fruit forms 27.68 percent of its diet. Hips of wild rose alone form 17.38 percent. Ernest Thompson Seton, who examined hundreds of stomachs of the sharp-tailed grouse, says that he can not recollect an instance in which they did not contain the stony seeds of the wild rose (*Rosa blanda* [?]).[a] The Biological Survey has found rose seeds in many of the stomachs examined, but in numerous instances it has recorded their absence. The fruit of both prairie rose and the sweetbrier (*Rosa rubiginosa*) are eaten. Mr. Seton states that in places in Manitoba where he has collected during the winter, gravel to pulverize the food is not to be had, and the stony rose seeds act in its stead. Rose hips appear difficult to digest, and, furthermore, are sometimes thickly set with bristles that would irritate the human stomach, but appear to cause no inconvenience to the grouse. The persistent bright-colored hips are readily seen above the snow, and they are a boon to the birds in wintry northern regions, where the struggle for existence is bitter. Other plants of the rose family furnish food for the sharp-tailed grouse, such as the thorn apple (*Cratægus* sp.), the wild strawberry, and the wild black cherry (*Prunus serotina*). It feeds on blueberries and cranberries and on the snowberry (*Symphoricarpus racemosus*), various species of manzanita, bearberry (*Arctostaphylos uva-ursi*), buffalo berry (*Lepargyrea argentea*), juniper berries, huckleberries, and arbutus berries. It takes also the partridge berry (*Mitchella repens*), a favorite with the ruffed grouse. Like many other species, it eats with relish the fruit of cornel (*Cornus stolonifera*) and poison ivy (both *Rhus radicans* and *Rhus diversiloba*).

THE SAGE GROUSE.

(*Centrocercus urophasianus.*)

With the exception of the wild turkey, the sage grouse is our largest game fowl. It is a fine-looking bird, with gray back, black breast, and long tail, and attains a maximum weight of 8 pounds. It breeds on the sagebrush plains of the Upper Sonoran and Transition zones, from the east slope of the Sierra Nevada and Cascade mountains in Nevada, California, and British Columbia, east to Assiniboia, Dakota, Nebraska, and Colorado. At mating time the cock inflates the sacs

[a] Proc. U. S. Nat. Mus. XIII, p. 519, 1890 (1891).

on the sides of his neck until they look like small oranges, and then goes through a droll performance, throwing himself forward on his breast and plowing along the ground until the breast feathers are almost completely worn away. The hen is captivated by these grotesque antics, and in due time chooses a mate and nests in a small depression in the ground under the shelter of a bush, where she lays about ten olive-buff eggs with chocolate markings. The cock leaves her before incubation begins, and in about three weeks the chicks are out. A young covey roosts in a circle on the ground, bobwhite-fashion. In winter, coveys unite in packs which sometimes number a hundred or more.

FOOD HABITS.

The feeding habits of the sage grouse are peculiar, and its organs of digestion are unlike those of other grouse. The stomach is not differentiated into a powerful grinding gizzard, but is a thin, weak, membranous bag, resembling the stomach of a raptorial bird. Such an organ is evidently designed for the digestion of soft food, and we find that the bulk of the sage grouse's diet consists of leaves and tender shoots. A stomach collected September 7, 1890, in Idaho, by Dr. C. Hart Merriam, contained leaves of sage and other plants, seeds, and a ladybird beetle (*Coccinellidæ*). Four birds shot in Wyoming during May and September by Vernon Bailey had gorged themselves with the leaves of sagebrush (*Artemisia tridentata*). This and other sages, including *A. cana* and *A. frigida*, furnish the bulk of the food of the sage grouse. Other food is taken, but it is comparatively insignificant. B. H. Dutcher, formerly of the Biological Survey, examined a stomach which, besides sagebrush leaves, contained seeds, flowers, buds of *Rhus trilobata*, and ants and grasshoppers. Three birds collected by Vernon Bailey on September 5, in Wyoming, had varied their sagebrush fare with ladybird beetles, ground beetles (*Carabidæ*), fly larvæ, ants, moths, grasshoppers (*Melanoplus* sp.), and the leaves of asters and yarrow. Of two birds killed in May, one had fed wholly on the leaves of sagebrush (*Artemisia tridentata*), while the other in addition had taken insect galls from sagebrush and the flowers and flower buds of a phlox (*Phlox douglasii*), together with some undetermined seed capsules, pieces of moss, and several ants. A third bird, killed in July, had eaten a few plant stems and numerous grasshoppers.

Major Bendire writes that the diet of the sage grouse includes grass spikes, the tops of leguminous plants, including blossoms and pods of vetch (*Vicia*) and astragalus; also, that the bird eats goldenrod, and will go far to get a morning feed of wheat. He notes that also berries, grasshoppers, and crickets (*Anabrus simplex*) are eaten.[a]

[a] Life Hist. N. A. Birds, [I], pp. 107–108, 1892.

SAGE GROUSE (CENTROCERCUS UROPHASIANUS).

Sage grouse have been known to eat rose hips, greasewood leaves, and the buds and foliage of the pulpy-leaved thorn.[a]

The young, of course, are more highly insectivorous than their parents. A half-grown bird shot by Vernon Bailey had eaten, in addition to vegetable food, some 300 ants.

Much remains to be learned about the diet of the sage grouse, but enough is known to show that the bird lives principally on sagebrush, and does no harm to agriculture. The value of the flesh as food has been much discussed, but the general opinion is that when the birds have not been feeding much upon sage the flesh is excellent. A long-continued diet of sagebrush imparts to it a bitter, sagy flavor. Hon. Theodore Roosevelt says:[b]

> However, I killed plenty of prairie chickens and sage hens for the pot, and as the sage hens were still feeding largely upon crickets and grasshoppers, and not exclusively on sage, they were just as good eating as the prairie chickens.

Sage grouse should be drawn as soon as they are killed, to prevent the food in the stomach and intestines from tainting the flesh. The sage grouse is of very gentle disposition, and probably would thrive in captivity. Should it be domesticated, its size would make it a most valuable fowl. E. S. Cameron, of Terry, Mont., writes to the Biological Survey that he has made a beginning in this direction. He secured eggs of the sage grouse, hatched them under a domestic hen, and some of the chicks survived.

THE RUFFED GROUSE.

(*Bonasa umbellus.*)[c]

The ruffed grouse is widely distributed over the wooded parts of the United States and Canada, and ranges from northern Georgia, Mississippi, and Arkansas north to Hudson Bay and central Alaska, and from Maine to the coast of Oregon. The different conditions of environment prevailing over this great range have had their effect in modifying the colors of the ruffed grouse so that several forms may be distinguished. The color differences between the bird of the southern Rocky Mountains and the Oregon ruffed grouse of the humid west coast are especially marked. The latter is the most richly colored of the North American grouse, and is notable for its handsomely

[a] Wilson and Bonaparte, Am. Ornith., IV, p. 214, 1831.

[b] The Wilderness Hunter, p. 99, 1893.

[c] The ruffed grouse is separable into four forms: The common bird of the Eastern States (*Bonasa umbellus*); the Canadian ruffed grouse (*B. u. togata*) of the spruce forests along the northern border, from Maine to British Columbia; the gray ruffed grouse (*B. u. umbelloides*) of the Rocky Mountains, north to Alaska; and the Oregon ruffed grouse (*B. u. sabini*) of the humid west coast, from northern California to British Columbia.

6568—No. 24—05 M——4

contrasted black and reddish brown colors, set off by immaculate white.

The ruffed grouse is one of the most highly prized of American game birds. It is known in New England as the 'partridge,' but in the Southern States it is usually called 'pheasant.' It is distinctly a bird of the woods, imparting the spirit of the wilderness to every sylvan retreat that it inhabits. In Virginia and Maryland, near the city of Washington, the species is, or was until recently, not uncommon along the rocky palisades of the Potomac and in deep gorges lined with laurel thickets. In Essex County, N. J., it frequents the crest of a wooded basaltic dike known as the Orange Mountains, where the picturesque rocky woods with a good stand of deciduous trees and an undergrowth of blueberry, second-growth white oak, wild grape and bittersweet vines, and beds of partridge berry (*Mitchella repens*) furnish a congenial home. That ruffed grouse usually prefer deciduous to evergreen growths was particularly noticed by the writer in 1892 and 1898 at Chocorua, N. H., a hamlet between Lake Winnepesaukee and the White Mountains. On his tramps through heavy spruce forests remote from houses or clearings he seldom came across grouse. He frequently met them, however, in woodland near farms or in clearings, and particularly along wood roads. A favorite ground in August was the clearing of an abandoned farm, 200 feet above Chocorua Lake, which lies at the foot of Chocorua Mountain. The fields are separated from one another by little trout brooks and have grown up to young spruces. Here in bowlder-strewn pastures was an abundance of blackberries, blueberries, and grasshoppers, with old apple trees, birches, and poplars for winter budding. On this old farm the writer never failed to flush from three to eight grouse, and on several occasions he saw hen birds with young. In a sandy spot of the road leading up to the house the grouse had dusting wallows, which they used habitually. During October birds were often found in hemlock woods with an undergrowth of osmunda ferns or other vegetation.

The ruffed grouse does not congregate in large coveys, like the plumed quails or the prairie chicken, but is found in companies of from two to eight, usually members of a single brood. It does not spend the night on the ground, but perches on a tree. When the weather is very cold, however, it often plunges into the snow and passes the night as snugly as an Eskimo in his igloo.

The bobwhite whistles, the prairie chicken booms, and the blue grouse hoots, but the ruffed grouse drums. The drumming is one of the most interesting and attractive of all bird performances. It may be heard at every season, but is at its best in spring. The cock, then in full vigor, mounts his drumming log, droops his wings, raises his fantail, and struts along the log with his crest and glossy black neck

tufts erect. He begins beating his wings slowly; then faster and faster, till their rapid reverberation becomes a tattoo, rolling out a challenge to rival cocks and a love call to the hens.

Nesting takes place in the latter part of April, or more often early in May. In a makeshift nest scratched in a hollow are laid ten or a dozen or even more creamy white or buffy eggs, usually unspotted, but sometimes with fine specks of brown. The young look like little brown leghorn chicks. Only one brood is raised in a season. On July 4, in New Jersey, the writer has seen young birds as large as woodcock. The cock grouse assist neither in incubation nor in rearing the young, but after the eggs are laid assemble in small companies by themselves. The hen is amply able to care for her little family, and Mr. Sandys tells how a mother forced to headlong and unvalorous flight a young pointer that had designs on her brood.[a] The notes of the grouse during the breeding season are interesting. When the brood is surprised the hen utters several clucking sounds, one of which may be described as 'quit, quit, quit.' Mr. Sandys, in writing of the call of the parent birds to scattered chicks, says:[b]

> In about ten minutes there sounded a low musical chirruping, very like the sound emitted by a red squirrel between the coughing, sputtering notes.

Major Bendire, quoting Doctor Ralph, says that a disturbed mother grouse utters a sound like the whine of a young puppy.[c]

Of the habits and general attractiveness of the ruffed grouse Major Bendire writes as follows:[d]

> The Ruffed Grouse is naturally tame and unsuspicious, and let it once realize that it is protected, it becomes almost as much at home in the immediate vicinity of man as a domestic fowl, and quickly learns to know its friends. At the fine country residence of the Hon. Clinton L. Merriam, near Locust Grove, N. Y., especially during the winter, it is not an unusual sight to see several of these handsome birds unconcernedly walking about the shrubbery surrounding his home, and even coming on the veranda of the house to feed. They, like many other animals about the place, have learned that here at least they are among friends, and plainly show their full confidence in them. Even during the mating season a cock Grouse may frequently be seen in the act of drumming within 50 yards of some of the outbuildings.

Bird Lore, for May–June, 1904, has an account of a wild hen grouse which was so tame that it would come out of the woods at call and allow itself to be picked up, thus displaying the most unbounded confidence in its human neighbors. To lovers of nature the æsthetic value of this beautiful bird is very great, and its value is none the less, although it can not be measured in cash.

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[a] Upland Game Birds, pp. 118–119, 1902.
[b] Ibid., p. 119, 1902.
[c] Life Hist. N. A. Birds [I], p. 62, 1892.
[d] Ibid., p. 60, 1892.

The ruffed grouse affords grand sport; indeed, with not a few sportsmen it holds higher place even than bobwhite. In flight it is one of the swiftest of upland game birds, and considerable skill, a quick eye, and a steady hand are needed to shoot it on the wing. Most shots must be made in cover, and the bird's habit of putting a tree between itself and the sportsman as it flies away adds to the difficulty. As a rule it does not lie nearly so close to a dog as bobwhite, but before a well-trained, cautious animal it lies fairly well. When brought to bag the grouse is a noble prize. From six to nine birds may be called a good day's bag, worth more than several times as many bobwhites. The excellence of this grouse as a table delicacy causes the market supply generally to fall far short of the demand, and the price is always high. If the bird could be successfully bred in captivity, it would furnish a most valuable food.

PRESERVATION AND PROPAGATION.

The ruffed grouse has a number of potent enemies. Most dangerous of all is probably that destructive biped, man. Writing from Minnesota, Dr. P. L. Hatch says:[a]

> Nowhere was the ruffed grouse more abundant than in all the deciduous forests of this State, until mercilessly slaughtered by the pot hunters. * * * But their glorious day is passing away as fast as about 300 dogs and 700 double-barreled breech-loading shotguns can accomplish their annihilation.

Many market hunters of the grouse use a little cur dog trained to tree the game and to bark until the gunner approaches within range. Of the numerous natural enemies, hawks, owls, crows, skunks, minks, wild cats, and foxes are very destructive, and in certain localities a species of tick often infests the birds. Among the birds of prey, the Cooper hawk, goshawk, red-shouldered hawk, barred owl, and great horned owl are their worst enemies. At Marshall Hall, Md., the writer found a crow plundering the nest of a grouse. Almost everybody who is personally familiar with the habits of the fox has found it feeding on game birds. At Chocorua the writer came upon the den of a red fox about which were strewn tail feathers of the ruffed grouse. Owners of shooting preserves will do well to destroy systematically all vermin injurious to game. The bird should have better protection also from man. Massachusetts still permits landowners to snare grouse on their own lands during October and November. Such destructive and unsportsmanlike practices should be prevented everywhere by well-enforced laws. The abominable practice by summer campers of potting grouse when they have young should also be punished by a strict enforcement of the law. In sections

[a] Birds of Minnesota, p. 160, 1892.

where grouse are decreasing under persistent gunning the open season should be further limited or even eliminated for a period of years[a] until the birds have recovered something of their former numbers. A reasonable limit to the day's bag should be set by law. Kansas, Maine, and Wisconsin restrict the number to 15; Montana and Oregon to 10, and Ohio to 6. Vermont, Pennsylvania, and Connecticut have a limit of 5 grouse per day to a gun, and in the latter State, as well as in New York, no more than 36 can be taken in a year. By similar laws other States can aid in the preservation of the bird.

The grouse in captivity often becomes tame. Sometimes, indeed, it takes kindly to the henhouse. It has laid in captivity, and its eggs found in the woods have been hatched under domestic hens, but thus far nothing like successful grouse culture has been approximated, though there appears to be no reason why under proper conditions it should not be successful. Comprehensive knowledge of the bird's food habits should assist in solving the problem.

FOOD HABITS.

The food habits of the ruffed grouse have been investigated in connection with the present paper by the examination of 208 stomachs and crops. This material represents food taken in every month, but chiefly in the colder half of the year. New York supplied more material than any other section; Canada, Pennsylvania, and Massachusetts came next; and Nebraska, Virginia, Maryland, Kentucky, New Hampshire, Iowa, Illinois, Minnesota, Michigan, Wisconsin, and South Dakota each contributed a smaller part. Analysis of the food showed 10.92 percent of animal matter and 89.08 percent of vegetable matter. The animal food is almost all insects. The vegetable food consists of seeds, 11.79 percent; fruit, 28.32 percent; leaves and buds, 48.11 percent, and miscellaneous vegetable matter, 0.86 percent. The insect food proper includes grasshoppers, 0.78 percent; caterpillars, 1.15 percent; beetles, 4.57 percent, and miscellaneous insects, 3.86 percent. Some miscellaneous animal matter, made up of spiders and snails, is also eaten. The ruffed grouse eats a somewhat smaller proportion of insects than the bobwhite, but, like it, feeds on them to a large extent in the breeding season.

Insect Food.

Grouse shot by the writer at Chocorua, N. H., in September, 1898, were feeding largely on the red-legged grasshopper (*Melanoplus*

[a] In Ohio the season has been closed until 1908, in Illinois until 1909, and in Missouri until 1910.

femur-rubrum), which was unusually abundant in pastures where the birds foraged. They had picked up also long-horned grasshoppers (*Xiphidium* sp.) and a few black crickets. Crickets often swarm in fields during fall, and offer tempting morsels to birds. The ruffed grouse occasionally eats such caterpillars as cutworms, army worms, cotton worms (*Alabama argillacea*), the red-humped apple worm (*Schizura concinna*), and the oak-leaf caterpillar (*Symmerista albifrons*). A number of observers, among them Doctors Fisher and Weed, report that it feeds on oak caterpillars.

The ruffed grouse, like the bobwhite, prefers beetles to any other insects. It takes almost as many of them as of all other kinds put together, including even such small ones as the clover weevil (*Sitones hispidulus*). It likes also the injurious leaf-eating beetles (*Chrysomelidæ*), destroying even the notorious potato beetle (*Leptinotarsa decemlineata*). It eats the pale-striped flea beetle (*Systena blanda*), as well as many other leaf beetles, including *Systena hudsonias*, *Disonycha caroliniana*, *Chætocnema* sp., *Galerucella sagittariæ*, and the grapevine pest, *Adoxus vitis*. By scratching, the grouse unearths many pests not found by other birds, notably beetle larvæ, click beetles, and May beetles, including *Lachnosterna hirsuta*. It also consumes another injurious beetle, *Dichelonycha* sp., closely related to the May beetles and resembling them in habits and appearance. It scratches up many ground beetles belonging to *Pterostichus*, *Anisodactylus*, *Harpalus*, and other genera. Beetles of other families also—fireflies (*Lampyridæ*), metallic wood borers (*Buprestidæ*), and *Calitys scabra* (*Trogostidæ*)—are in the food list.

The grouse feeds also on such miscellaneous insects as flies, bugs, ants, and such other Hymenoptera as sawflies and ichneumon flies. A large proportion of the flies are slow-flying species, like crane flies, which are preyed upon by many other kinds of birds. Bugs, however, are much more often destroyed by bobwhite and the ruffed grouse than by other birds. The ruffed grouse has been known to prey on the chinch bug, which at times is the most injurious insect in our country, and seldom destroyed by any except gallinaceous birds. Farmers who permit market hunters to rob them of their game should remember this fact. The grouse picks up also many other bugs, among them predaceous species like the ambush bug (*Phymata* sp.) and the assassin bug (*Reduviidæ*). They eat also homopterous insects, including leaf hoppers (*Jassidæ*) and buffalo tree hoppers (*Membracidæ*).

Like many other birds, the ruffed grouse eats ants, frequently including such large species as *Camponotus pennsylvanicus*. Among small ants may be mentioned the pavement ant (*Tetramorium*

cæspitum). Several species of the useful parasitic ichneumons are occasionally taken, and as an offset such foliage-destroying insects as sawflies, including adult forms of *Nematus* sp. and larvæ of *Lophyrus* sp. A peculiar long-bodied hymenopteron (*Pelecinus* sp.) also has been noted. The queerest article of food, perhaps, is the galls produced by insects (*Cynipidæ*). The ruffed grouse shows a marked liking for these odd growths, which contain a few tiny larvæ. The common semidomestic pheasant of England has the same taste. The grouse usually selects galls growing on oaks, often those produced by species of the genus *Amphibolips*. A bird shot in Lunenburg, Mass., in October had eaten 12 of these oak galls, although at that time other food was abundant.

Few invertebrates other than insects were found in the investigation of the food of the grouse. The miscellaneous animal food, however, included representatives of such Myriapoda as the thousand-legs, of the order *Diplopoda*, and such Arachnida as harvest spiders (*Phalangidæ*), jumping spiders (*Attidæ*), and ground spiders (*Lycosidæ*); snails of the genus *Helix*, and also shell-less snails, or slugs, including *Limax* sp. and *Tebennophorus carolinensis*.

Vegetable Food.

The vegetable food examined consisted of 11.79 percent of seeds, 28.32 percent of fruit, 48.11 percent of buds and leaves, and 0.86 percent of miscellaneous vegetable matter. Grain was not found, though no doubt it would be eaten if obtainable. In fact, Major Bendire says that grouse procure it along roads from the droppings of horses.[a]

The seed element of the food is mast and miscellaneous seeds. The mast—5.33 percent—consists of hazelnuts, beechnuts, hornbeam seeds, chestnuts, and acorns. The last, furnishing by all odds the largest supply, includes those of the scrub oak (*Quercus nana*), scrub chestnut oak (*Q. prinoides*), white oak (*Q. alba*), and red oak (*Q. rubra*). Acorns are often swallowed whole, half a dozen to a dozen at a meal being not uncommon. Beechnuts also are taken whole, and from 20 to 60 are sometimes found in a crop.

Miscellaneous seeds make up 6.46 percent of the entire food. Like many other gallinaceous birds, the ruffed grouse takes some leguminous seeds, though fewer than might be expected. The kinds known to have been eaten are the tick-trefoil (*Meibomia* sp.), so abundant in the edge of woods frequented by grouse, and vetch (*Vicia caroliniana*). Winged seeds are often sampled, such as those of the hem-

[a] Life Hist. N. A. Birds, [I], p. 62, 1892.

lock, the pitch pine, and the maple. The following miscellaneous seeds are taken by the ruffed grouse:

Blackberry lily (*Belamcanda chinensis*).
Beggar-ticks (*Bidens frondosa*).
Chickweed (*Alsine media*).
Sheep sorrel (*Rumex acetosella*).
Sedge (*Carex lupulina*).
Sedge (*Cyperus* sp.).
Violet (*Viola* sp.).
Witch-hazel (*Hamamelis virginiana*).
Beech-drops (*Leptamnium virginianum*).
Avens (*Geum* sp.).
Persicaria (*Polygonum pennsylvanicum*).
Frost weed (*Helianthemum canadense*).
Jewel weed (*Impatiens* sp.).

The list is interesting mainly for what it does not contain. Further investigations may show that the ruffed grouse, like the bobwhite and other so-called granivorous species, is fond of ragweed, sunflower, and grass seed. A grouse taken in British Columbia during October showed a peculiar liking for the apparently dry husks of geum seeds, no fewer than 500 appearing in its crop.

BUDS AND LEAVES.

The ruffed grouse spends most of its feeding time in browsing and berry picking. It thus secures, respectively, 48.11 percent and 28.32 percent of its food. The country boy knows where it resorts for budding, and often bags it without the aid of a dog or hammerless gun. The buds and foliage of poplar, birch, and willow form 20.20 percent of the entire food. Budding is most practiced in winter and early spring, when many other kinds of food are buried in snow. Birch and poplar buds afford by far the largest share of this cold-weather diet. Edward A. Preble says that in Canada in spring the sitting hen grouse leave the nest, fly to poplar trees, rapidly fill their crops with buds, and then hurry back to their eggs. He thinks that the males, having plenty of time to spare at that season, prefer to search for choicer food. The crop of a hen bird that he shot at Fort Chipewyan, Athabasca, May 29, 1901, was filled with young leaves of poplar (*Populus balsamifera*). The number of buds to a meal is surprising. A grouse shot at Palmer, Mich., December 15, 1894, contained 300 poplar buds. When engaged in budding, grouse take both flower buds and leaf buds; grown leaves of poplar also are eaten, and, not infrequently, the flattened petioles that catch the wind and give the leaves their characteristic quiver. *Populus balsamifera*, *P. tremuloides*, and *P. grandidentata* are among the species on which they feed. Birch buds also are a staple; they are taken from the canoe birch (*Betula papyrifera*), the gray birch (*B. populifolia*), the yellow birch (*B. lutea*), and the black birch (*B. lenta*). Everybody who is familiar with New England woods has seen the

grouse at dusk balancing on the ends of birch branches and snipping off buds. As with the poplar, both leaf buds and flower buds are taken. A grouse shot in Quebec December 18, 1896, had filled its crop with 200 catkins of the canoe birch. As a rule birds appear to prefer the male to the female flowers. Baird, Brewer, and Ridgway are authority for the statement that in Maine the buds of black birch are so freely eaten that they impart to the bird's flesh a distinctive and agreeable flavor. The ruffed grouse feeds also on the buds and leaves of different species of willow, as Major Bendire[a] and other authors have reported. A bird shot on Roseau River, Minnesota, October 20, 1896, had eaten 20 willow flowers. In budding, the grouse often clips from a fourth to half an inch of a twig which bears two or three buds.

In addition to the buds and leaves of willow, birch, and poplar, browse from miscellaneous plants provides the bird with 27.91 per cent of its food. Such relatives of the willow as the alder, hazel, beech, ironwood, and hornbeam furnish a part of the above. Apple trees on outlying parts of farms are favorite sources of supply. This fact, noted by many observers and confirmed by the present investigation, has given rise to considerable discussion as to whether or not the trees are seriously injured by the budding. Dr. Clarence M. Weed says:[b]

> The ruffed grouse, however, is capable of inflicting real damage by a too close pruning of buds, and cases are known where apple orchards located near woods have been rendered useless by them.

Mr. C. J. Maynard states that he took 180 apple buds from one crop, and says that in Massachusetts at one time a bounty of 25 cents was offered by certain towns for the birds' heads.[c] Miss M. E. Paine, of Royalston, Mass., in a letter to the writer describes her observations on the budding of apple trees by grouse as follows:

> The ruffed grouse eats the buds of apple trees, but it is a help rather than a damage. Last year a wild apple tree on top of a hill, between pasture and mowing, was almost entirely budded. I thought entirely at first, but the terminal buds were almost always left uninjured, also many minute buds on each limb. The result was the terminal buds were pushed out and grew rapidly and strongly. The tree blossomed abundantly and the fruit hung in clusters toward the ends of the branches. The tree is of medium size and the branches droop to the ground. In the fall the golden apples occupied fully as much room as the green leaves, and as one looked at the tree a few rods away—a perfect picture, barrels of apples on it, all nearly perfect and fair, just the result of a vigorous trimming. This year it was not so badly budded—less snow in winter. Many small buds farther back in the branches have started again this

[a] Life Hist. N. A. Birds, [I], p. 66, 1892.

[b] Birds in Their Relation to Man, p. 40, 1903.

[c] Birds of Eastern N. A., p. 353, 1881.

year and grown, and it is well fruited, owing to the budding two years in succession. No tree could have been more entirely budded, but the grouse can not stand so as to reach the outmost terminal buds, as a rule; their weight is too great.

The present investigation of stomachs revealed only an insignificant percentage of apple buds, probably because most of the grouse examined were shot in places remote from orchards. The bird has been known to eat also pear and peach buds, and probably would not refuse cherry buds. From one crop, leaves of blackberry or raspberry (*Rubus* sp.) were taken, and bud twigs of blueberry (*Vaccinium pennsylvanicum*) and other species were not at all uncommon. The twigs severed by the sharp-edged bill of the grouse are all about the same length, one-third of an inch. They appeared in the stomachs as little whitish sticks, from which digestion had removed the bark. The extent to which the ruffed grouse browses on leaves and twigs suggests an herbivorous mammal rather than a bird.

The ruffed grouse feeds on leaves and buds of the mayflower (*Epigæa repens*), and likes exceedingly the leaves of the partridge berry (*Mitchella repens*). It nips off also leaves of both red and white clover, to the extent of 1 percent of its food. It is partial to the leaves of sheep sorrel (*Rumex acetosella*), which it cuts across as sharply as if by a pair of scissors, but it eats yellow sorrel (*Oxalis stricta*) with less relish. It appears to like dandelion greens, and has a queer taste for the fronds of ferns (*Dryopteris spinulosa*, *Botrychium obliquum*, and *Polypodium vulgare*). In its relation to conifers it differs widely from the spruce grouse, for it derives therefrom only an insignificant percentage of its food, while the spruce grouse obtains nearly 50 percent. Spruce needles and foliage of arborvitæ (*Thuja occidentalis*) have been seen in several stomachs. Edward A. Samuels believes that the ruffed grouse will eat leaves of evergreens only when all other food is lacking.[a] In Alaska, E. W. Nelson found the bird feeding exclusively on spruce buds. He states that the flesh becomes disagreeable from this pitchy diet.[b] The effect of highly flavored food on the flesh of game birds has already been referred to.

The ruffed grouse buds the highly poisonous laurel (*Kalmia latifolia*). On this subject Alexander Wilson writes:[c]

> During the deep snows of the winter, they have recourse to the buds of alder, and the tender buds of the laurel. I have frequently found their crops distended with a large handful of these latter alone; and it has been confidently asserted, that, after having fed for some time on the laurel buds, their flesh becomes highly dangerous to eat, partaking of the poisonous qualities of the plant.

[a] Our Northern and Eastern Birds, p. 387, 1883.
[b] Nat. Hist. Coll. in Alaska, p. 131, 1888.
[c] Am. Ornith., vol. II, p. 319, 1831.

Dr. John H. Brinton, of Jefferson Medical College, has known several cases of glossitis (inflammation of the tongue) caused by eating grouse that had fed on laurel,[a] and Dr. N. Shoemaker has also known of serious illness from the same source.[b] V. K. Chestnut, Department specialist on poisonous plants, gave an extract made from laurel leaves to a chicken, which he subsequently killed and fed to a cat. The cat was seriously affected, but ultimately recovered. In Philadelphia in 1790 the public was alarmed over the possibilities of laurel poisoning, and the sale of these birds was for a time forbidden. Dr. B. H. Warren shot 10 birds when the ground was deeply covered with snow, and found their crops stuffed with laurel buds.[c] Not more than half a dozen stomachs of the 208 examined by the Biological Survey contained fragments of this plant, the explanation probably being that only a few stomachs were collected in late winter, when birds most resort to it. Four of the birds that contained laurel were used for food, with no evident ill effect. One of these had eaten 14 grams of laurel, nearly all leaves, with only a few buds. The leaves had been clipped into bits as if by scissors. Investigation of this habit of the grouse, known to be a common one, is much needed. The maple is often selected for budding, and sometimes the spicebush. Flowers are sometimes plucked by browsing grouse. Asters and red clover have been identified in their food, and the green ovary of bloodroot (*Sanguinaria*) was found in a bird's crop by Amos W. Butler.

The following plants also are in the list of browse of this bird:

Heuchera (*Heuchera americana*).
Chickweed (*Alsine pubera*).
Catnip (*Nepeta cataria*).
Cinquefoil (*Potentilla argentea*).
Buttercup (*Ranunculus bulbosa* and *R. acris*).
Speedwell (*Veronica officinalis*).
Saxifrage (*Saxifraga* sp.).
Live-forever (*Sedum* sp.).
Meadow rue (*Thalictrum* sp.).
Smilax (*Smilax glauca*).
Horsetail rush (*Equisetum* sp.).
Azalea (*Azalea* sp.).
False goat's beard (*Astilbe* sp.).
Aster (*Aster* sp.).
Cud weed (*Gnaphalium purpureum*).

FRUIT.

The ruffed grouse is preeminently a berry eater. Not only does it consume more fruit than the bobwhite, but it is our most frugivorous game bird. More than one-fourth of its yearly food—28.32 percent—consists of fruit, distributed as follows: 3.82 percent rose hips, 2.46 percent poison ivy and sumac, 3.01 percent grapes, and 19.03 percent miscellaneous fruits.

[a] Warren, Birds of Penn., p. 108, 1890.
[b] North Am. Med. Journ., I, pp. 321–322, 1826.
[c] Birds of Pennsylvania, p. 108, 1890.

The taste for rose hips, seedy and husky as they are, and often beset with fine bristles which irritate the human skin and would seem really dangerous to internal tissues, is one of the singular freaks of bird feeding. It reminds one of the cuckoo's liking for caterpillars which are so bristly that its stomach becomes actually felted and sometimes pierced by the stiff hairs. Rose hips hang on the bushes throughout the winter, accessible to the hungry grouse as they journey about in the snow for food, and are usually swallowed whole.

The bird likes grapes also. No less than 3.01 percent of the year's diet consists of them, and in November they make 17.2 percent of the total food for the month. All experienced sportsmen know of this taste, and during this month they always count on getting their best shooting in the vicinity of heavily fruited grapevines. The wild grapes with small berries, such as *Vitis cordifolia*, are especially liked, but also large grapes are greatly relished. The species from which cultivated varieties have been derived (*Vitis labrusca*) appears to be commonly selected. Thirty to forty grapes are often swallowed at a meal. From this taste one might expect the grouse to commit depredations on cultivated grapes, but no reports of such damage have come to the Biological Survey.

Like many other birds, the ruffed grouse eats the berries of sumac and other species of *Rhus*. This food contributes 2.46 percent of the year's diet. Among the nonpoisonous sumacs selected are the dwarf sumac (*Rhus copallina*), the staghorn sumac (*R. hirta*), and the scarlet sumac (*R. glabra*). Not uncommonly from 300 to 500 berries of the dwarf sumac are swallowed at a meal. This liking for the dry and apparently nonnutritious sumac is another curious freak of bird appetite. Probably, as with the bobwhite, the seeds are broken up in the gizzard and the inclosed meat, or endosperm, set free for digestion. The immunity of the bird from poisoning by poison sumac and poison ivy, which also it eats, is interesting. That these seeds retain their virulence after being eaten was shown in the case of an investigator in the Biological Survey who was poisoned while examining stomachs of crows that had fed on poison-ivy berries. At times the ruffed grouse eats many of these berries, as proven by one collected by Prof. S. A. Forbes, at Jackson, Ill., December 9, 1880, which had eaten 280 of them. Where grouse are numerous, poison sumac is usually less abundant than poison ivy, and consequently it appears less frequently in stomach examinations. One hundred and sixty poison-ivy berries were taken from the crop of a ruffed grouse shot by Dr. A. K. Fisher at Lake George, N. Y., October 24, 1892.

Miscellaneous fruits amount to 19.03 percent of the annual food. The two favorite kinds are the partridge berry (*Mitchella repens*) and the thorn apple (various species of *Cratægus*), both of which were eaten by 40 of the 208 grouse examined. At least two species

of thorn apple are used for food—the cockspur thorn (*Cratægus crus-galli*) and the scarlet thorn (*C. coccinea*). These apple-like fruits afford a nutritious food. At Peterboro, N. Y., the writer observed grouse coming to thorn-apple trees during November and well into December. That they take large numbers at a meal is shown by an individual obtained at St. Vincent, Minn., which had eaten 38. W. H. Kobbé says that grouse eat with great relish the small wild crab apple of the Northwest (*Pyrus rivularis*).[a] They enjoy cultivated apples, seldom missing a chance at trees on the edge of woodlands. At Chocorua, N. H., in October, 1898, some of the birds killed in old orchards of abandoned farms had fed principally on apples. After thorn apples and partridge berries, a number of other fruits are also staples. The large brilliant clusters of the mountain ash (*Sorbus americana*) are acceptable, and the delicious wintergreen berries, with scarlet skin and snowy pulp, are also relished. The bayberry (*Myrica carolinensis*) is a favorite food wherever accessible. In grouse stomachs one often finds nothing but the little round granules contained in the waxy drupes of this berry. Blueberries also are eaten in large quantities. A bird killed at Chocorua, N. H., July 25, 1892, had eaten a hundred blueberries (*Vaccinium pennsylvanicum*), and one killed at Chateaugay, N. Y., in September, contained about three hundred. The high-bush blackberry and the huckleberry also are eaten, as well as the cranberry. Dr. A. K. Fisher found 21 whole cranberries in a bird shot at Lake George, N. Y., November 2, 1901. The extent to which blackberries are sometimes eaten is shown by the fact that the stomach of a grouse contained about 800 blackberry seeds. Another bird had eaten over a hundred sarsaparilla berries. An explanation of the delicious flavor of the ruffed grouse appears in its varied and highly flavored diet of fruit, herbs, and seeds. In addition to the fruits already noted the following kinds found in the birds examined may be named, though the total number mentioned in this bulletin is probably not a fourth of the complete list of fruits eaten by this bird:

Greenbrier (*Smilax* sp.).
Hairy Solomon's seal (*Polygonatum biflorum*).
Smooth Solomon's seal (*Polygonatum commutatum*).
Blackberry (*Rubus nigrobaccus*).
Black raspberry (*Rubus occidentalis*).
Raspberry (*Rubus strigosus*).
Domestic cherry (*Prunus avium*).
Cultivated plum (*Prunus domestica*).
Wild black cherry (*Prunus serotina*).
Wild red cherry (*Prunus pennsylvanica*).
Elder (*Sambucus canadensis*).
Red elder (*Sambucus pubens*).
Black haw (*Viburnum prunifolium*).
Nannyberry (*Viburnum lentago*).
Withe rod (*Viburnum cassinoides*).
Maple-leaved arrow wood (*Viburnum acerifolium*).

[a] Auk, XVII, p. 351, 1900.

High-bush cranberry (*Viburnum opulus*).
Mountain cranberry (*Vaccinium vitis-idæa*).
Snowberry (*Symphoricarpus* sp.).
Feverwort (*Triosteum perfoliatum*).
Black huckleberry (*Gaylussacia resinosa*).
Black alder (*Ilex verticillata*).
Flowering dogwood (*Cornus florida*).
Bunchberry (*Cornus canadensis*).
Cornel (*Cornus paniculata*).
Silky cornel (*Cornus amonum*).
Pepperidge (*Nyssa sylvatica*).
Mulberry (*Morus rubra*).
Bittersweet (*Celastrus scandens*).
Manzanita (*Arctostaphylos* sp.).
Barberry (*Berberis vulgaris*).
Virginia creeper (*Parthenocissus quinquefolia*).

The seeds of most of these berries pass through the digestive tract unharmed and are capable of germinating. Thus the grouse assists in planting many fruiting trees and shrubs, the heavy seeds of which must be disseminated mainly through the agency of animals that feed on them.

Food of the Young.

The young of most birds are far more insectivorous than adults, a statement that applies to gallinaceous birds, though to a less extent than to passerines. More than 95 percent of the diet of eight grouse chicks examined, none of which was more than a fourth grown, was insects. Seven adults collected in the breeding season had consumed only 30 percent of insects. Newly hatched chicks eat the largest proportion of insects. As they grow older they gradually become more frugivorous and granivorous. Three chicks, only a day or two old, collected by Prof. S. A. Forbes, at Waukegan, Ill., June 9, 1876, proved to have been exclusively insectivorous. They had eaten cutworms, grasshoppers, Lampyrid beetles, ants (*Tetramorium cæspitum*), parasitic wasps, buffalo tree hoppers, and spiders (*Attidæ* and *Phalangidæ*). A grouse about a week out of the shell, collected by F. H. King, had eaten a white grub, 7 spiders (*Phalangidæ*), and 13 caterpillars.[a] It should be noted, therefore, that the ruffed grouse, though only slightly insectivorous when adult, as a chick destroys great numbers of insects, and deserves much more credit from farmers than it usually receives.

THE SPRUCE GROUSE.

(*Canachites canadensis.*)[b]

The spruce, or Canada, grouse inhabits the transcontinental coniferous forests from the northern border of the United States, east of

[a] Trans. Wis. Ag. Soc., vol. 24, pp. 472–473, 1886.

[b] The spruce grouse (*Canachites canadensis*) is separated into three geographic forms, of which two occur within our territory; these are the common spruce grouse (*C. c. canace*) of the northern border from Maine to Minnesota, and the Alaska spruce grouse (*C. c. osgoodi*) of Alaska and western Canada.

the Rocky Mountains, to Labrador and Alaska. The male is one of the handsomest of the grouse; it is gray, with black bars above and clear black and white below, with a rusty band edging its fanlike tail. In spring brilliant red combs above the eyes add to the beauty of the strutting cock. These birds drum in an odd way: The male selects an inclined tree and flutters up the trunk for 15 to 20 feet, drumming as he goes. The spruce grouse nests in May or early June and lays from 9 to 16 buff-colored eggs, handsomely marked with rich chestnut and brown.

FOOD HABITS.

Study of the food habits of the spruce grouse has been but meager, since only 8 stomachs were available for examination. These were collected in January, May, August, September, October, and November, 6 of them in Canada, 1 in Michigan, and 1 in Minnesota. The material in the stomachs consisted of 100 percent vegetable matter—18.33 percent seeds, 19.73 percent fruit, 61.94 percent coniferous foliage. The seeds were of spruce, thistle, and several unidentifiable plants. In its frugivorous habits the spruce grouse closely resembles its relative, the blue grouse. The proportion of bearberries was 16.67 percent, and of other fruit 3.06 percent. Solomon's seal (*Polygonatum*), blueberries (*Vaccinium*), bunchberries (*Cornus canadensis*), crowberries (*Empetrum*), and juniper berries are among the berries principally eaten. Dr. C. Hart Merriam, Chief of the Biological Survey, has informed the writer that the spruce grouse feeds largely on the bearberry (*Arctostaphylos uva-ursi*) and the wax currant (*Ribes cereum*).

When cold weather comes the spruce grouse usually abandons a berry diet and eats nothing but its favorite food—the leaves, buds, and tender shoots of conifers. This kind of browse formed 61.94 percent of the food of the eight birds examined in the laboratory. It is safe to assume that more than half the year's food of this grouse is obtained by browsing, and that nearly half consists of the foliage of conifers. Wilson and Bonaparte state that in winter this species feeds on the shoots of spruce,[a] a habit so generally known that it has given to the bird its name. According to Major Bendire, this grouse feeds also on the needles of tamarack (*Larix laricina*), and in certain localities feeds upon them exclusively.[b] It has been known also to eat the needles of *Pinus divaricata* and the fir balsam (*Abies balsamea*). As with the blue grouse, resinous food imparts to the flesh a decidedly pitchy flavor.

W. H. Osgood, of the Biological Survey, informs the writer that he examined crops of the Alaska grouse which contained the leaves

[a] Am. Ornith., vol. 4, p. 208, 1831.

[b] Life Hist. N. A. Birds, [I], p. 52, 1892.

of blueberry (*Vaccinium*) and horsetail (*Equisetum*). The Alaska spruce grouse, according to Dr. W. H. Dall, was found at Nulato in winter feeding exclusively on the buds of willow.[a]

The flesh of the spruce grouse is dark and for the table is in no way comparable to that of the blue grouse. Nor is the bird equal to the latter as an object of sport. It is, however, a thing of beauty in the dark northern coniferous forests, where its æsthetic value must impress every lover of nature. This grouse is strictly a forest bird, and nowhere appears to come into contact with agriculture.

THE FRANKLIN GROUSE.

(*Canachites franklini.*)

The Franklin grouse is very similar to its near relative, the spruce grouse, and differs mainly in the conspicuous white marking on its upper tail coverts and in lacking the rufous tip to the tail. It is found in the mountains of western Montana and Idaho, westward to the coast ranges of Oregon and Washington and northward through British Columbia to southern Alaska. Major Bendire records that nidification occurs during the last of May and in June. The food habits of the bird are similar to those of the spruce grouse. In Alberta, between August 25 and September 1, 1894, J. A. Loring, a field agent of the Biological Survey, examined the crops of several Franklin grouse and found in them berries and leaves. A. H. Howell, also of the Survey, examined crops and gizzards in Idaho during the last of September, 1895, and found in them large quantities of the leaves of the lodge-pole pine (*Pinus murrayana*) broken into bits from one-fourth to three-fourths of an inch long. Major Bendire notes that in summer they furnish Indians and packers with their principal supply of fresh meat. Their flesh is palatable then because they eat grasshoppers and berries and feed less freely on the buds and leaves of spruce and tamarack.[b]

Hon. Theodore Roosevelt writes of this bird in Montana:[c]

> The mountain men call this bird the fool-hen; and most certainly it deserves the name. The members of this particular flock, consisting of a hen and her three-parts grown chicks, acted with a stupidity unwonted even for their kind. They were feeding on the ground among some young spruce, and on our approach flew up and perched in the branches, four or five feet above our heads. There they stayed, uttering a low complaining whistle, and showed not the slightest suspicion when we came underneath them with long sticks and knocked them off their perches.

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[a] Nelson, Nat. Hist. Coll. Alaska, p. 130, 1887 (1888).

[b] Life Hist. N. A. Birds, [I], p. 58, 1892.

[c] The Wilderness Hunter, p. 116, 1893.

THE DUSKY GROUSE.

(*Dendragapus obscurus.*)[a]

The dusky, or blue, grouse lives mainly in coniferous forests of the western mountain ranges, occurring in the Rocky Mountains from New Mexico, Arizona, and Colorado, north to Canada and Alaska, and west to the Pacific coast. These grouse are large, plainly colored birds, mainly of a slaty or dusky shade. In unfrequented forests they are so unsophisticated that they often perch on a low branch and gaze curiously at an intruder until struck by a stone or stick. From their unsuspicious nature they are known in parts of the West, like the previous species, as fool-hens. While commonly habitants of the higher forests, they often descend to lower levels on the mountain sides where deciduous trees and bushes mingle with the conifers.

The dusky grouse is a valuable food bird and weighs from 2½ to 3½ pounds. Wilbur C. Knight says:[b]

> Of all the edible birds of the west this and the following variety [Richardson's grouse] are the most desirable. The flesh is highly flavored, tender, juicy, and as white as that of a tame fowl.

The flavor of a game bird's flesh is often affected by the character of its diet, as is the case with the blue grouse after it has been feeding on the pitchy foliage of conifers. "The use of such food imparts to the flesh of these birds," says Major Bendire, "a strong resinous flavor, not particularly relished by me at first."[c] Baird, Brewer, and Ridgway, however, state that the pine taste only improves the bird's gamy flavor.[d] Vernon Bailey states that half-grown young of the blue grouse which had been feeding largely on gooseberries were excellent eating, being entirely free from pitchiness. George B. Grinnell, editor of Forest and Stream, notes that a diet of a small species of red whortleberry also makes the flesh delicious.[e]

As an object of sport the blue grouse is in the front rank of game birds, even though it spends much time in the deep coniferous forests. It lies well to the dog, flies swiftly, and affords shots in heavy timber that test the sportsman's highest skill.

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[a] In addition to the common dusky grouse (*Dendragapus obscurus*) of the Rocky Mountains from New Mexico to Montana, three other geographic forms are known. These are the sooty grouse (*D. o. fuliginosus*) of the northwest coast, from California to southern Alaska; Richardson grouse (*D. o. richardsoni*), from Montana to northwestern British America; and the Sierra dusky grouse (*D. o. sierræ*) of the Sierra Nevada in California and east slope of Cascade Mountains in Oregon.

[b] Birds of Wyoming, p. 54, 1902.

[c] Auk, vol. 6, p. 33, 1889.

[d] Hist. N. A. Birds, vol. 3, pp. 424–425, 1874.

[e] Forest and Stream, vol. 12, p. 365, 1879.

The dusky grouse cock is quite uniformly dark in color, as the name implies. In the mating season the bird presents a striking appearance. The brilliant comblike wattles above its eyes are conspicuous, the large, yellow wind sacs on the sides of its neck are fully inflated, and it struts about like a turkey cock, with drooping wings and spreading tail, emitting a sound that closely resembles the hooting of the great horned owl. The nesting takes place during the last half of May, when the hen bird scratches a slight hollow in the earth and lays from 6 to 12 cream-colored, brown-spotted eggs. Usually but one brood is reared in a season. Prof. W. W. Cooke, in writing of the habits of the species in Colorado, says that it breeds from 7,000 feet altitude to timber line, 4,000 feet higher. At the former altitude it lays about the middle of May. In August the birds gather in flocks and visit grainfields, or frequent the more open gulches and foothills for berries. In September they wander above timber line to feed on grasshoppers, reaching an altitude of 12,500 feet. In severe winter weather some of the birds come down into the thick woods, but many remain the whole year close to timber line.[a]

FOOD HABITS.

The food habits of the dusky grouse have been studied by examination of the contents of 45 crops and stomachs, representing every month of the year except May, June, and November. Most of the birds were shot in British Columbia, Colorado, and Idaho, but a few came from Montana, Utah, Wyoming, and California. The food consisted of 6.73 percent animal matter—insects, with an occasional spider—and 93.27 percent of vegetable matter—seeds, fruit, and leaves. Grasshoppers constitute the bulk of the animal food, amounting to 5.73 percent. Beetles, ants, and caterpillars form the rest of the insect food. One stomach contained the common land snail (*Polygyra* sp.). Major Bendire, Vernon Bailey, and Walter K. Fisher have shown that the young birds feed largely on grasshoppers. Mr. Fisher shot a young bird at Forest Grove, Oreg., July 6, 1897, which had eaten 20 grasshoppers and several smooth, green larvæ.

VEGETABLE FOOD.

The dusky grouse and its near relative, the spruce grouse, are among our chief foliage-eating birds. Browse is eaten by the blue grouse to the extent of 68.19 percent of its annual food, and is distributed as follows: Buds and twigs, 5.28 percent; coniferous foliage, 54.02 percent; other leaves, 8.89 percent. The species spends most of

[a] Birds of Colorado, p. 70, 1897.

its time in pine forests feeding on needles, buds, and flowers. The yellow pine (*Pinus ponderosa*)—male flowers, the white fir (*Abies concolor*), *Abies magnifica*, the Douglas fir (*Pseudotsuga mucronata*), the western hemlock (*Tsuga heterophylla*), and the black hemlock (*Tsuga mertensiana*) are among the trees that afford it subsistence. That the blue grouse thus utilizes the foliage of conifers is well known to everybody familiar with the bird. Major Bendire writes that during the winter its food consists almost wholly of the buds and tender tops of pine and fir branches, refuse bits of which sometimes accumulate under a single tree to the amount of a bushel.[a] A blue grouse shot by W. W. Price at Slippery Ford, Cal., when 15 feet of snow lay on a level, had filled its crop with the young leaves of the white fir.[b] Plants other than conifers furnish 14.17 percent of the annual food of the species. This material includes red clover leaves, willow leaves, blueberry leaves, miterwort (*Mitella breweri*), birch shoots, and poplar flower buds. During July, in Montana and Utah, field agents of the Biological Survey have seen the bird feeding on the leaves, buds, and flowers of the Mariposa lily (*Calochortus*). It eats also the blossoms of lupine, columbine, and the Indian paint brush (*Castilleja*).

The blue grouse is only slightly granivorous. Its seed food amounts to but 4.99 percent of the whole—a proportion small indeed when compared with that of the bobwhite and the crested quails. The species is said by Alexander Wilson to resort to seeds only when other food is scarce.[c] At times it visits fields for oats and other grain. It feeds also on pine seeds (*Pinus flexilis* and other species). It picks up polygonum seeds (*P. polymorphum* and others), is fond of wild sunflower seeds, and has been known to sample false sunflower (*Wyethia mollis*), caraway (*Glycosma occidentalis*), and the capsules of *Pentstemon gracilis*. It picks up also the seeds of various species of lupine, and is fond of acorns, including those of the canyon live oak (*Quercus chrysolepis*).

The blue grouse is one of the most highly frugivorous of our gallinaceous birds. Fruit formed 20.09 percent of the food of the 45 birds whose stomachs were examined in the laboratory. Manzanita berries constituted a large part, amounting to 13.48 percent of the total. During the summer and early fall they were eaten in great quantities. The manzanita often forms tangled areas of chaparral and includes a number of species which furnish birds and mammals an abundant supply of berries. The berries eaten by the blue grouse

[a] Auk, vol. 6, p. 33, 1889.
[b] Condor, vol. 3, p. 160, 1901.
[c] Am. Ornith., vol. 4, p. 191, 1831.

include *Arctostaphylos pungens*, *A. nevadensis*, and *A. uva-ursi*. Its list of fruits also includes the following:

Mountain twin berry.
Red elder (*Sambucus pubens*).
Honeysuckle (*Lonicera involucrata; Lonicera conjugialis*).
Cherry (*Prunus* sp.).
Mountain ash (*Sorbus sambucifolia*).
Salmon berry (*Rubus parviflorus*).
Service berry (*Amelanchier alnifolia*).
Salal (*Gaultheria shallon*).
Huckleberry (*Vaccinium occidentale*).
Currant (*Ribes cereum, Ribes sanguineum*).
Gooseberry (*Ribes menziesii*).

The food habits of all young birds differ more or less from those of their parents. Young blue grouse at first live chiefly on grasshoppers and other insects and on tender plant tops. Later in the season they subsist on berries, such as gooseberries and salal-berries, and some seeds, such as those of the wild sunflower. Florence Merriam Bailey, in writing recently of the habits of the dusky grouse in New Mexico, says:[a]

> Near our camp at the foot of Pecos Baldy, Mr. Bailey discovered a winter roosting tree of the grouse. The tree was on a sheltered part of the wooded slope and was so densely branched that after a prolonged rain the ground beneath was perfectly dry. The earth was strewn with winter droppings, composed entirely of the leaves of conifers. Conifer needles had also been eaten by three of the grouse that were taken * * * in July and August, but at this season the birds were living principally on such fresh food as strawberries, bearberries (*Arctostaphylos uva-ursi*), sheperdia berries, flowers of the lupine and paint brush, seeds, green leaves, grasshoppers, caterpillars, ants, and other insects. One crop contained twenty-seven strawberries, twenty-eight bearberries, and twelve sheperdia berries, besides flowers, leaves, and insects, while the accompanying gizzard was filled with seeds, green leaves, and insects.

THE WILLOW PTARMIGAN.

(*Lagopus lagopus.*)

Ptarmigans are characteristic of the arctic and arctic-alpine regions. During summer they are mainly gray and brown, resembling the mottled colors of the bare earth, but at the approach of winter they change this plumage for one of pure white. Thus they harmonize with their surroundings at all seasons and are better able to escape their numerous enemies. There are four species of these birds in the United States and Alaska. Of these the willow ptarmigan, white ptarmigan, or willow grouse, as it is variously known, is the largest, most abundant, and consequently the most important. It is found in the arctic regions of both hemispheres, and is widely spread and abundant throughout the tundra country of Alaska, except on the Aleutian Islands. Throughout its range, especially in winter, it is an important food bird. In the north

[a] Auk, vol. 21, p. 351, 1904.

periods of famine are ever recurring among the natives, and these birds frequently stand between them and starvation. It rears but one brood in a season, nesting on the ground early in June and laying from 7 to 12 eggs. By the middle of August the young are nearly grown. In the northern part of its range the willow ptarmigan is a summer resident only, and at the approach of winter most of the birds migrate in large flocks, sometimes numbering a thousand or more, southward or inland to a region of scattered trees or bushes. Ernest Thompson Seton, quoting from Hutchins' manuscript concerning observations at Hudson Bay in 1782, says that over 10,000 ptarmigans were caught with nets at Severn from November to April.[a] The birds are so tame, especially in winter, that their capture is easy. Like all other gallinaceous birds, ptarmigans require gravel for milling their food, and in winter deep snow makes this hard to procure. The natives, taking advantage of the birds' necessities, bait their nets with gravel, and sometimes catch as many as 300 at one spring of a net.[b] E. W. Nelson writes of encountering flocks of several thousand white ptarmigans in Alaska in midwinter, and says that the whirring of their wings as they rose sounded like the roll of thunder and seemed to shake the ground. He reports that the birds are snared and shot in great numbers by both the Alaskan Eskimos and the Indians.[c] The flesh is not so palatable as that of many other game birds, and is decidedly dry and often bitter when the bird feeds on willow buds. The flesh of old birds is dark colored, but that of the young is white and delicately flavored.

FOOD HABITS.

Study of the food of the willow ptarmigan unfortunately has been slight, for only five birds were available. Their food was entirely vegetable. Three shot in January in Labrador had eaten 10 percent of berries and 90 percent of buds, more than half the buds being willow. One stomach contained about 300 willow-flower buds. The two other birds were collected in December in Labrador and had eaten willow buds exclusively. Though the data are so scanty, the results agree with those of other students. Ludwig Kumlien, for instance, says:[d]

> They [willow ptarmigans] are quite common in the larger valleys, where there is a ranker growth of willows. The stomachs of those I examined of this species contained willow buds and small twigs.

[a] Proc. U. S. Nat. Mus., vol. 13, p. 514, 1890.
[b] Hearne, Journey to the Northern Ocean, pp. 413–415, 1795.
[c] Nat. Hist. Coll. in Alaska, p. 132, 1887 (1888).
[d] Bull. 15, U. S. Nat. Mus., pp. 82–83, 1879.

Baird, Brewer, and Ridgway have stated that the crops of ptarmigans were often found to contain a double handful of willow buds.[a] L. M. Turner writes thus of the bird in Alaska:[b]

> During the winter these birds subsist on the past year's twigs of willow and alder or other bushes. I have cut open the crops of many of these winter-killed birds and found them to contain only pieces of twigs about one-third of an inch long, or just about the width of the gape of the posterior horny part of the bill, as though this had been the means of measurement in cutting them off. The flesh at this time is dry and of a peculiar taste. In spring the ptarmigans congregate in great numbers on the willow bushes and eat the tender, swelling buds. The flesh then acquires a bitter but not unpleasant taste. As open weather advances they find berries that have remained frozen the entire winter, and tender grass shoots, and later, insects. The young are insectivorous to a great degree in their youngest days. They consume great numbers of spiders that are to be found on the warm hillsides.

In writing of the food of the willow grouse, Major Bendire says that the buds and tender leaves of birch are eaten, and the berries of cranberry, whortleberry, and arbutus.[c] Wilson and Bonaparte state that it feeds on berries, including the crowberry (*Empetrum nigrum*) and the mountain cranberry (*Vaccinium vitis-idæa*).[d]

THE ROCK PTARMIGAN.

(*Lagopus rupestris.*)[e]

The rock ptarmigan inhabits arctic America from Labrador to Alaska (including the entire Aleutian chain, where the willow ptarmigan is unknown). It is similar to the latter bird, but smaller and has a black line from the bill to the eye by which it may readily be distinguished. This bird is less common than the willow ptarmigan and prefers more rocky and elevated situations. Owing to its smaller size and fewer numbers it is far less important to the people of the north as an article of food than the willow ptarmigan.

FOOD HABITS.

No stomachs of the rock ptarmigan have been available for examination. In Alaska, during May, E. W. Nelson found it feeding on berries of the preceding season.[f] Major Bendire says that the sub-

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[a] Hist. N. A. Birds, Land Birds, III, p. 461, 1874.

[b] Nat. Hist. Alaska, p. 153, 1886.

[c] Life Hist. N. A. Birds, [I], p. 74, 1892.

[d] Am. Ornith., IV, p. 328, 1831.

[e] Besides the typical *Lagopus rupestris* of arctic America, the rock ptarmigans of North America include the Reinhardt ptarmigan (*L. r. reinhardi*), of Greenland and northern Labrador; the Welch ptarmigan (*L. welchi*), of Newfoundland; and four forms found in the Aleutian Islands—*L. r. nelsoni*, *L. r. atkhensis*, *L. r. townsendi*, and *L. evermanni*.

[f] Nat. Hist. Coll. Alaska, p. 136, 1887 (1888).

species *Lagopus rupestris reinhardi* feeds on insects, leaves, berries, including the crowberry (*Empetrum nigrum*), tender leaves of the dwarf birch and white birch, willow buds, and sorrel.[a] Samuel Hearne notes that the rock ptarmigan eats the buds and tops of the dwarf birch (*Betula glandulosa*).[b] Kumlien examined a crop that was crammed with sphagnum moss.[c]

THE WHITE-TAILED PTARMIGAN.

(*Lagopus leucurus.*)

The white-tailed ptarmigan is found above timber line in Alaska, in the mountains of British Columbia, and in the higher Cascades south to Mounts Hood and Jefferson. It ranges south along the Rocky Mountains through Colorado to northern New Mexico. Unlike the other species, this ptarmigan has no black feathers in the tail. Writing of this bird in Colorado, W. W. Cooke says that it breeds above timber line, virtually under arctic conditions, and that only in most severe winters does it descend into timber. He records that it breeds at from 11,500 to 13,500 feet altitude, and wanders up to the summits of peaks 1,000 feet higher. Nesting takes place early in June and is similar to that of other ptarmigans. In winter, when the birds descend to lower altitudes, the sexes are in different flocks.

The white-tailed ptarmigan is a trusting creature, lacking the fear necessary for self-preservation. Clark P. Streator, while employed by the Biological Survey in the Cascade Mountains of Washington, reported that one could approach within 10 feet of it, that miners killed it with stones, and that it was very good for food.

In Colorado public sentiment is strongly in its favor, and it is protected by an absolutely prohibitory law. The ptarmigan is one of the sights pointed out to tourists in the Colorado mountains. Its status here may be contrasted with that of the willow grouse in the north, where thousands are killed by Eskimos and Indians. Killing birds for food, however, even by wholesale, has its excuse, but wholesale slaughter for millinery purposes, such as has overtaken the ptarmigans in the Old World, is unpardonable. A single shipment of ptarmigan wings in Russia consisted of 10 tons.[d]

FOOD HABITS.

During winter in Colorado, according to Professor Cooke, they subsist, like other ptarmigan, largely on willow buds. The stomachs

[a] Life Hist. N. Am. Birds, [I], p. 80, 1892.
[b] Journey to Northern Ocean, p. 416, 1795.
[c] Bull. 15, U. S. Nat. Mus., p. 83, 1879.
[d] Engelhardt, A Russian Province of the North, 1899.

of two birds collected at Summitville, Colo., in January, 1891, at an altitude of 13,000 feet, were found to contain bud twigs from one-third to one-half inch long, but the kind of bush from which they came could not be determined. Doctor Coues, quoting T. M. Trippe, states that the food of this bird is insects, leguminous flowers, and the buds and leaves of pines and firs.[a] According to Major Bendire, the flowers and leaves of marsh marigold (*Caltha leptosepala*) and the leaf buds and catkins of the dwarf birch (*Betula glandulosa*) are eaten.[b] Dr. A. K. Fisher examined the stomachs of two downy chicks collected on Mount Rainier, Washington, and found beetles and flowers of heather (*Cassiope mertensiana*) and those of a small blueberry.

THE WILD TURKEY.

(*Meleagris gallopavo.*) [c]

The wild turkey, our biggest game bird, was formerly abundant over a wide area. It has been exterminated throughout much of its former range, and unless radical measures are taken it will become extinct in a few years. In early colonial days it was numerous in Massachusetts, coming about the houses of the settlers in large flocks. It is now totally extinct in New England. It is hard to realize that at the beginning of the nineteenth century turkeys were so abundant that they sold for 6 cents apiece, though the largest ones, weighing from 25 to 30 pounds, sometimes brought a quarter of a dollar. A big wild turkey nowadays would not long go begging at $5. It is their value as food that has made it worth while to hunt turkeys to the very point of extermination. So-called sportsmen go out in the late summer ostensibly to shoot squirrels, but really to pot turkeys on the roost. Another practice is to lie in ambush and lure the game by imitating the call note of the hen in spring. The writer has personal knowledge of such methods of hunting in Virginia and Maryland, and they are largely responsible for the extermination now imminent. Trapping turkeys in pens—a very simple matter—has also accelerated the destruction of the species.

William Brewster found the turkey breeding in North Carolina among the conifers at 5,000 feet altitude, and also in the hardwoods at low altitudes. Edward A. Preble, of the Biological Survey, dis-

[a] Birds of the Northwest, p. 427, 1874.

[b] Life Hist. N. A. Birds, [I], pp. 85–86, 1892.

[c] The typical *Meleagris gallopavo* is restricted to Mexico; but four geographic races have been recognized within the United States. These are the wild turkey of the Eastern States and the Mississippi Valley (*Meleagris gallopavo silvestris*); the Florida turkey (*M. g. osceola*); the Rio Grande turkey (*M. g. intermedia*); and the Merriam turkey of Colorado, New Mexico, Arizona, and the table-land of northern Mexico (*M. g. merriami*).

covered a turkey's nest, in June, 1893, in Somerset County, Pa., which contained 14 eggs. William Lloyd states that the Texas turkey breeds twice a year. He found a nest, May 29, containing 8 eggs. The chicks, like those of the tame turkey, are very delicate, and are especially sensitive to wet. Audubon says that during wet weather they are fed by their mothers with the buds of spice bush, much as human youngsters are dosed with quinine.[a] When the chicks are 2 weeks old they fly up and roost on low branches with their mother. At this age they have weathered most of their early perils.

During the last of December, 1902, along the Roanoke River, near the North Carolina line, the writer found turkeys in typical turkey country. Few of the plantations here are under a thousand acres, and many include three or four thousand. Along the river are lowlands, often flooded during high water. Several hundred yards farther back is a bluff, the old river terrace, which marks the beginning of the uplands. A part of this bluff, half a mile long by an eighth of a mile wide, consists of a slate outcrop, much elevated above the rest and varying from 50 to 150 feet above the river. It is locally known as 'the mountain,' and is heavily forested with pine and oak. The turkeys were found on the backbone of the 'mountain,' among white oak trees, where fresh droppings and places where the birds had scratched in the dry oak leaves to the depth of 2 or 3 inches were visible. So recently had the birds been there that the humus had not dried. The scratching places were from 15 to 18 inches in diameter and circular in shape. In the growth of white oaks there were fully fifty scratching holes, as many as five being found within one square rod, where the birds had made diligent search for acorns. A turkey dog was sent ahead and soon flushed a bird, which came flying by, looking like a giant ruffed grouse. All through the woods were turkey blinds, some made of young pine trees and others, more elaborate, of logs. Most of the turkeys killed here are shot by calling them up to these blinds. In a patch of rank broomsedge and briers a 20-pound gobbler sprang into the air and was shot while making off in clumsy fashion. It had not had time to eat much, and the stomach and crop contained seven dipterous larvæ, the remains of white-oak acorns, and about a hundred flowering dogwood berries. On the 15th of June, 1903, two broods of young about the size of game hens were seen.

FOOD HABITS.

The Biological Survey has examined, in all, 16 stomachs and crops of wild turkeys. These were collected during February, March, July, September, November, and December. They contained 15.57 percent

[a] Ornith. Biog., vol. 1, p. 7, 1831.

of animal matter and 84.43 percent of vegetable matter. The animal food consisted of insects—15.15 percent—and miscellaneous invertebrates, such as spiders, snails, and myriapods—0.42 percent. Grasshoppers furnished 13.92 percent, and beetles, flies, caterpillars, and other insects 1.23 percent.

The 84.43 percent of the bird's vegetable food was distributed as follows: 'Browse,' 24.80 percent; fruit, 32.98 percent; mast, 4.60 percent; other seeds, 20.12 percent; miscellaneous vegetable matter, 1.93 percent.

The wild turkey is very fond of grasshoppers and crickets. William Hugh Robarts has observed a flock of a hundred busily catching grasshoppers.[a] Vernon Bailey, of the Biological Survey, killed a turkey at Corpus Christi, Tex., in May, 1900, that had eaten a large number of grasshoppers and a sphinx moth. During the Nebraska invasion of Rocky Mountain locusts, Professor Aughey examined the contents of six wild turkey stomachs and crops collected during August and September. Every bird had eaten locusts, in all amounting to 259.[b] The wild turkey has been known also to feed on the cotton worm[c] (*Alabama argillacea*), the leaf hoppers, and the leaf-eating beetles (*Chrysomela suturalis*). The grasshopper (*Arnilia* sp.) and the thousand-legs (*Julus*) form part of the turkey's bill of fare. Tadpoles and small lizards also are included.

Besides the bird shot on the Roanoke, already mentioned, the stomachs and crops of four other Virginia turkeys have been examined by the Biological Survey. One of these contained only small quartz pebbles. Another bird had eaten only a few grapes and flowering dogwood berries. A third had made a respectable meal. Ten percent of its food was animal matter and 90 percent vegetable. The animal part consisted of 1 harvest spider (*Phalangidæ*), 1 centipede, 1 thousand-legs (*Julus*), 1 ichneumon fly (*Ichneumon unifasiculata*), 2 yellow-jackets (*Vespa germanica*), 1 grasshopper, and 3 katydids (*Cyrtophyllus perspiculatus*). The vegetable food was wild black cherries, grapes, berries of flowering dogwood and sour gum, 2 chestnuts, 25 whole acorns (*Quercus palustris* and *Q. velutina*), a few alder catkins, seeds of jewel weed, and 500 seeds of tick-trefoil (*Meibomia nudiflora*). Another turkey, also shot in December, had eaten a ground beetle, an ichneumon fly, 2 wheel bugs, 10 yellow-jackets, a meadow grasshopper, 75 red-legged grasshoppers, a few sour-gum berries, some pine seeds (with a few pine needles, probably taken accidentally), several acorns, a quarter of a cupful of wheat, and a little corn.

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[a] Am. Field, vol. 55, p. 42, 1901.

[b] First Rep. Ent. Com., App. II, p. 46, 1878.

[c] Fourth Rep. Ent. Com., p. 88, 1885.

One turkey, collected December 23, 1899, in North Carolina, had eaten half a pint of dogwood berries. Its crop contained also a few pine needles. Four Florida wild turkeys also were examined. Nearly 100 percent of their food was vegetable. The animal matter was found in two birds and consisted of the useful predaceous ground beetle (*Scarites subterraneus*) and the injurious 12-spotted cucumber beetle (*Diabrotica 12-punctata*); also caterpillars (*Hadena turbulenta*), grasshoppers (*Melanoplus arboreus* and *Arnilia* sp.), 2 dragon flies (*Libellula* sp.), and 1 centipede. This is the only record of the first-mentioned grasshopper's occurrence in Florida. A third turkey had eaten half a pint of long-leafed pine seeds. Many of these seeds were germinating, and some of them had cotyledons more than an inch long. The Florida bobwhite also is very fond of these pine seeds. The same bird had eaten three thimblefuls of grass seed (*Panicum minimum*), 12 spicebush berries (*Benzoin benzoin*), 20 berries of the wax myrtle (*Myrica cerifera*), 2 live-oak acorns (*Quercus virginiana*), and 15 acorns of the Spanish oak (*Quercus digitata*). Another turkey had taken 25 tubers of the ground nut (*Apios apios*)—some of them exceeding an inch in length—and the berries of false Solomon's seal (*Polygonatum* sp.), southern tupelo, and wax myrtle. Half a pint of the fruiting panicles of a grass (*Muhlenbergia* sp.) was taken from the crop of a New Mexican turkey shot in November in the Manzano Mountains. It had eaten also grass blades, seeds of cheat, piñon nuts, and seeds of other pines.

Although grain was found in only one stomach, the writer observed turkeys on the Roanoke bottoms in December, 1903, feeding on corn after the crop had been harvested. During November and December half of the food of the turkey is fruit. The kinds most frequently eaten include, besides those already mentioned, myrtle holly (*Oreophila myrtifolia*), mulberries, wild strawberries, blackberries, cedar berries, and holly berries. On San Francisco Mountain, Arizona, Dr. C. Hart Merriam found turkeys in August feeding on wild gooseberries. A month later, at the same locality, he found them living on piñon nuts.[a] In Arizona E. A. Goldman found a flock of 150 young and old turkeys that roosted in one place. The gobblers were at this time in a separate flock. These birds were feeding on nuts of the piñon (*Pinus edulis*), a staple Indian food of the West. They ate also juniper berries (*Juniperus utahensis*).[b] On the upper Gila River, New Mexico, in November, 1873, H. W. Henshaw found turkeys very numerous and feeding almost exclusively upon grass seeds and grasshoppers, the crops of many birds being fairly crammed with the former. Major Bendire says that the Florida turkey feeds on

[a] N. A. Fauna, No. 3, p. 89, 1890.
[b] Auk, vol. 19, p. 123, 127, 1902.

white-oak acorns, chinquapins, chestnuts, pecan nuts, black persimmons, fruit of prickly pear, leguminous seeds, all cultivated grains, and tender tops of plants.[a] Wild turkeys feed also on mountain rice (*Oryzopsis pringlei*), mesquite beans, sedge, poa grass, and composite flowers.

Florence Merriam Bailey, in writing of the wild turkey in New Mexico, says:[b]

> Mr. Vilas, a cattleman of the country, told us that in the fall they go down to the nut pine and juniper mesas in the Glorieta region and, gathering at the few springs that furnish drinking places, are shot by wagon loads by the Mexicans. The only specimen we obtained was taken July 27, at over 11,000 feet. Its crop and gizzard held mainly grasshoppers and crickets, but also grass seed, mariposa lily buds, and strawberries, while its gizzard contained in addition a few beetles.

The wild turkey consumes both insect pests and seeds of weeds, but now is nowhere abundant enough to have much effect on agriculture. The domestic turkey's habit of hunting grasshoppers and of 'worming' tobacco shows what might be expected from the wild species were it sufficiently numerous.

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[a] Life Hist. N. A. Birds, [I], p. 114, 1892.

[b] Auk, vol. 21, p. 352, 1904.

INDEX.

Page.

Alaska, ptarmigan, food values and snaring 44–45
Apple orchards, injury by grouse 18, 33
Blue grouse. *See* Dusky grouse.
Bobwhite, compared with prairie hen, notes 13, 14
value to farmer 9
Bonasa umbellus 25–38
Canachites canadensis 38–40
franklini 40
Centrocercus urophasianus 23–25
Colorado, law protecting ptarmigan 47
Conifers, foliage eaten by grouse and wild turkeys 34, 39, 40, 41, 42, 43, 48, 51
food of grouse, effect on flavor of flesh 41
Corn, eating by wild turkeys 51
Dendragapus obscurus 41–44
Dusky grouse, breeding habits 42
distribution 41
food for man, use 41
habits 41–44
of young 41, 44
general 41–44
object of sport 41
vegetable food 42–44
Farming, relations of grouse and wild turkey 8, 9, 14, 40, 52
Food, bird, effect on flavor of flesh, notes 25, 34, 37, 39, 40, 41, 46
habits, grouse, Dusky 41–44
Franklin 40
Ruffed 29–38
Sage 24–25
Sharp-tailed 21–23
Spruce 39–40
heath hen 18–19
prairie hen 13–18, 19, 20
ptarmigan 45–47
use of grouse 10–11, 20–21, 25, 40, 41, 44, 45, 46, 47, 48
wild turkey 48
Fool hen. *See* Franklin grouse.
Franklin grouse, distribution, habits, quality of flesh 40
Fruit buds, eating by grouse 18, 33–34
eating by grouse and turkey 18, 23, 35–38, 44, 51
Game, destruction 7, 28, 45, 47, 48
laws 12, 29, 47
Galls, oak, eating by grouse 31
Gooseberries, food grouse, effect on flavor of flesh 41
Grain, eating by grouse and wild turkey 17, 20, 22, 24, 31, 51
Grouse, distribution, usefulness, various species of United States 7–8
Dusky, distribution and general habits 41–44
forest regions, occurrence 8
Franklin, distribution and general habits 40
Ruffed, distribution and habits 25–38
Sage, distribution and general habits 23–25
Sharp-tailed, distribution and general habits 20–23
See also Heath hen and Prairie hen.
Heath hen, distribution, food habits, and danger of extinction 18–19
Insect food, prairie hen and grouse 14–15, 21–22, 29–31
wild turkeys 50, 51, 52
Insects, injurious, destruction by grouse and turkeys 14, 22, 30, 50

Page.
Kentucky, early abundance of grouse ---- 12
Lacey Act, game protection ---- 12
Lagopus lagopus ---- 44–46
leucurus ---- 47–48
lupestris ---- 46–47
Laws protecting game ---- 12, 29, 47
Lesser prairie hen, abundance, distribution, and food habits ---- 19–20
Locusts destroyed by grouse and turkeys ---- 14, 50
Maryland, trapping turkeys ---- 48
Mast, eating by grouse and wild turkeys ---- 31, 52
Meleagris gallopavo ---- 48–52
Minnesota, grouse, destruction ---- 28
New England, destruction of turkeys ---- 48
North Carolina, turkey hunting ---- 49
Oats, destruction by grouse ---- 17, 20, 22, 24, 43
Partridge. *See* Bobwhite *and* Ruffed grouse.
Pediocetes phasianellus ---- 20–23
Pheasant. *See* Ruffed grouse.
Plants eaten by grouse, list ---- 35
Poisonous plants, effect of eating on flesh of grouse ---- 34, 35, 36
Prairie hen, breeding habits, migration, description, distribution ---- 10, 20
domestication ---- 13
enemies ---- 13
food for man, use ---- 10–11
grain food ---- 17
habits ---- 13–18
of young ---- 18
insect food ---- 14–15
leaves, flowers, and shoots as food ---- 17–18
Lesser, distribution and habits ---- 19–20
man's ally ---- 11
object of sport ---- 11
propagation and preservation ---- 11–13
vegetable food ---- 15–18
Ptarmigan, Rock, distribution, value, and general habits ---- 46–47
White-tailed, distribution and general habits ---- 47–48
Willow, distribution, habits, and use as food for man ---- 44–46
Quail. *See* Bobwhite.
Restocking, grouse and turkey, importance ---- 9
Rock ptarmigan, distribution, value, habits ---- 46–47
food for man, use ---- 46
habits ---- 46–47
Ruffed grouse, æsthetic value ---- 27
breeding habits ---- 26–27
buds and leaves as food ---- 32–35
color differences ---- 25
description, general habits, food, etc ---- 25–38
distribution ---- 25
domestication, problem ---- 29
drumming habits ---- 26–27
enemies ---- 28
food for man, use ---- 28
habits ---- 29–38
of young ---- 38
fruit food ---- 35–38
insect food ---- 29–31
note ---- 27
object of sport ---- 28
preservation and propagation ---- 28–29
vegetable food ---- 31–38
Sage grouse, breeding habits and food habits ---- 23–25
distribution ---- 23
domestication ---- 25
food for man, use ---- 25
habits ---- 24–25
propagation ---- 25

Page.
Seeds, eating by grouse 16, 32, 40
Sharp-tailed grouse, breeding habits 20
description 20
distribution 20
food for man, use 20–21
habits 21–23
habits, general 20–21
insect food 21–22
vegetable food 22–23
Spice bush, food of turkey 49
Spruce grouse, æsthetic value 40
breeding habits 39
distribution, food habits 38–40
drumming 39
food for man, use 40
habits 39–40
object of sport 40
relation to agriculture 40
State game laws 12, 29, 47
Sumach, prairie hen food 16
Texas, destruction of prairie hen 20
Tobacco, "worming," by turkeys 52
Turkey, tame, origin 8
wild, abundance 8–9
breeding 48–49
destruction 9, 48, 52
distribution 8–9, 48
food for man, use and value 48
habits 49, 52
insect food 50, 51, 52
relation to agriculture 9, 52
shooting from blinds 49
species 8–9, 48
vegetable food 50, 51, 52
Tympanuchus americanus 10–18
cupido 18–19
pallidicinctus 19–20
Vegetable food, grouse, and turkey 15–17, 22–23, 31–38, 42–44
Weeds, destruction by grouse and turkey 16, 22, 52
Wheat, eating by grouse 17, 20, 22, 24
White-tailed ptarmigan, breeding habits 47
distribution 47
food for man 47
habits 47–48
habits, general 47
legislation 47
Whortleberry, effect of eating, on flesh of grouse 41
Wild turkey, abundance 48
breeding habits 48–49
decrease in numbers 9, 48
distribution 9, 48–49
food for man, use 8, 48
habits 49–52
habits, general 48–49
Willow ptarmigan, abundance 44–45
breeding habits 45
distribution 41–45
food for man, use 44–45
habits 41–45
habits, general 44–45
snaring, method 45

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LABORATORY OF ORNITHOLOGY
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